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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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See Advertisement page 59, Nov. 22. 3469

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Town Clerk. R 20

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Tenders, addressed as noted on the Form must be delivered at the Office of the Board not later than 10 a.m. on Wednesday, December 18th, 1918.
(By Order) T. DUNCOMBE MANN,
Clerk to the Board.
Nov. 29th, 1918. R 49

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The appointment will be held under the Warwickshire Education Committee.
The salary will be £600 per annum.
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Benn Buildings,
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A. B. PILLING,
Clerk of the Board.
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Finsbury Pavement,
London, E.C. 2,
23rd November, 1918. O 838

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Canvassing members of the Education Committee is prohibited, but printed copies of application and testimonials may be sent to them.
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GEORGE E. HILLEARY,
Town Clerk.
Education Department,
95, The Grove,
Stratford, E. 15.
28th November, 1918. R 10

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Faculty of Technology.

The Manchester Municipal COLLEGE OF TECHNOLOGY.

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for a modern blast furnace plant in South Wales, making hematite iron.—Apply, giving full particulars of experience, also salary required, to O 900, Offices of ENGINEERING.

THE PASSING OF PETROLEUM.

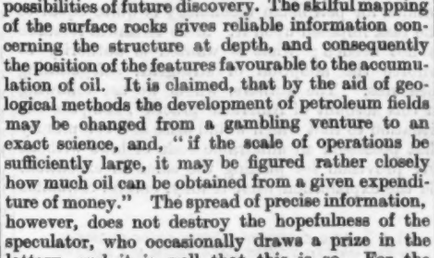
LITTLE more than half a century has elapsed since the sinking of the famous Drake well in Oil Creek, Pennsylvania, revealed to a wondering world the rich stores and vast possibilities of petroleum. Many still actively engaged in industry must be able to recall the days when petroleum was not, and have been able to watch the entire development of a marvellous chapter in the history of industrialism. They have seen how varied have been its applications and how in some or other of its many protean forms, it has quickened the productive power of the world. Its abundance in the United States was as astonishing as its varied employment, and the ease with which the mineral has been won has been as much a matter of envy as the facility with which it can be transported. When only three years ago the unexampled Cushing pool of Oklahoma was yielding 300,000 barrels daily, the stores seemed as inexhaustible as they were necessary to industrial progress. But to-day, a different and less welcome note is sounded. It is admitted that the supplies have suffered serious depletion and their approaching exhaustion is viewed with some uneasiness, as possible of accomplishment in the lifetime of those who have watched the growth of its influence on the success and the comfort of modern life. A short time ago, Dr. Ralph Arnold calculated that the estimated supply would last only twenty-two years (approximately), but believing that the total production of the United States would gradually decrease from year to year, he concluded that the total available supply could be spread out over a period of fifty to seventy-five years. This estimate was made in 1915, before America had linked her arms and her resources with those of the Allies. This co-operation, which could not have been foreseen, has greatly stimulated the demand without affecting a corresponding increase in the supply, and the interval separating us from the days of coming shortage must be curtailed. The gravity of the situation has called forth a more recent and more authoritative report,* which is deserving of close consideration, for the progress and well-being of the race depend very materially upon a cheap and abundant supply of petroleum. More than two-thirds of the world's total output comes from the States, and there is, unfortunately, the clearest possible proof that the consumption is exceeding the productive capacity of the country. The amount of stock reserves held in hand at the beginning of the last three years demonstrates the falling-off in production very clearly:—

	Barrels.
January 1, 1916, the stock estimated at	186,000,000
January 1, 1917, the stock estimated at	174,000,000
January 1, 1918, the stock estimated at	153,000,000

It must also be remembered that some 50,000,000 barrels are needed to fill the pipe lines. If the storage fell below this approximate minimum, the transport facilities, due to the liquidity of the crude product, would vanish, and the conduct of the whole industry be jeopardised. The authors are quite conscious of the gravity of the situation and state distinctly, that the output of 1917 cannot be maintained throughout 1918 "without the arrival of critical conditions, and a continuation through 1919 is impossible . . . while the total demands for petroleum are increasing at a growing rate, the rate of production is slowing, and there is scant hope of increasing the supply from Mexico." That the United States should already feel the necessity of drawing on the Mexican supply is significant, but such an expedient could only afford a temporary measure of relief. A larger problem will have to be faced when it is admitted that the total supply is not equal to the world's demand. Such a contingency is not pleasant to contemplate, and unfortunately it is one that cannot be comfortably relegated to a remote posterity.

Although the data collected by the Geological Survey are very trustworthy and their accuracy is fully recognised by mining engineers, it is not possible to gauge with any approach to nicety the amount of an unmined and undeveloped product. At the same time, it would be unwise to place any reliance on this margin of uncertainty, and urge that because the Cushing pool and some other well-known gushers appeared late in time, therefore it may be conjectured that other unknown sources, still greater in amount, will reward the fortunate prospector. The geology of petroleum pursued on strictly scientific lines has disclosed all the broad possibilities of future discovery. The skilful mapping of the surface rocks gives reliable information concerning the structure at depth, and consequently the position of the features favourable to the accumulation of oil. It is claimed, that by the aid of geological methods the development of petroleum fields may be changed from a gambling venture to an exact science, and, "if the scale of operations be sufficiently large, it may be figured rather closely how much oil can be obtained from a given expenditure of money." The spread of precise information, however, does not destroy the hopefulness of the speculator, who occasionally draws a prize in the lottery, and it is well that this is so. For the "wild-cat" operations favoured by small companies and individual prospectors have contributed much to the total output that has given America

Fig. 1. CHART SHOWING THE PRESENT TENDENCY OF THE UNITED STATES IN RESPECT TO ITS UNMINED RESERVE OF PETROLEUM. DATA FROM UNITED STATES GEOLOGICAL SURVEY.



the foremost position in the oil world. The chances of the random hole drilled in the vicinity of productive territory bringing good fortune to the lucky operator are steadily diminishing, and it is being brought home to those who stake their all on a winning chance "that he who plays geology has a 50 times better chance of striking oil than he who does not." The gambling aspect is losing some of its attractiveness with the disappearance of the chances and incentive of a rich reward: Fewer "wildcatters" will risk their own or other people's money in futile operations, and by diminishing the number of oil seekers the prospect of discovering new fields is lessened. All wells soon reach their maximum output, gradually decline, and eventually become extinct. New wells and additional exploiting, are necessary if production is to be sustained, and obviously, if production is to be increased. Hitherto youthful fields have come into operation, as the older have grown effete. But a limit must eventually be reached when new fields will not be forthcoming. There is no prospect of replacing the Kansas–Oklahoma and California fields, and signs that these two fields have reached their productive climax are not wanting.

In a return presented to Congress in 1916, founded on the known productive possibility of pools in active operation and also on the estimates from geologic evidence of undeveloped areas, the petroleum reserve calculated to a *per capita* basis on a population of 100,000,000, was as follows:—

—	*Per Capita* Rate of Production, 1917.	Mined to Date, 1859–1917.	Quantity Underground Available under present Methods of Mining.
	barrels.	barrels.	barrels.
Petroleum ..	3·4	42	70

With the increase of population, with a growing demand on one or other of the forms in which petroleum aids industry, and with the possibility, nay, certainty, of finding new fields of usefulness for its fractional distillates, one cannot doubt but that the consumption curve will take an upward course. A graphical representation (Fig. 1) taken from Messrs. Gilbert and Pogue's report may make the situation with which the United States are faced more impressive. It is evidently immaterial whether a little more or a little less slope is given to the line of "present tendency," the practical issue remains the same. Though a generous allowance of margin be made for possible underestimates of unmined petroleum, and for unforeseen contingencies, the same fact confronts us: A considerable and irreplaceable fraction of the domestic supply has been withdrawn and "whether that fraction is one-third, as present knowledge indicates, or one-fourth, or even one-fifth, makes no difference in the consideration demanded by the situation."

Exhaustion is a relative term. It is to be understood in the sense of coming scarcity, of a supply so far below requirements that the high price of the crude oil prohibits the application to many purposes for which petroleum now finds a ready and increasing demand. Apprehension is centred on the economic stress, rather than on the physical disappearance of the oil. The non-productiveness of a well does not imply that the whole of the oil has been extracted, but simply that its working under ordinary conditions has become unprofitable. Practically, it is estimated that 50 per cent. of the oil is left in the ground, filling the pores and capillary spaces of the rock. In considering the possible modifications that will relieve the tension and give a longer life to the oilfields, improved methods of working, aiming at more complete extraction will naturally find a place.

Before considering this point, it is well, though the results are sufficiently obvious, to glance at the consequences that follow a diminished yield, or even a stationary yield of crude petroleum upon national prosperity. The reactions and mutual inter-relationships between pivotal industries are complicated and far-reaching. Refinery technique derives from the crude four main products—gasoline, kerosene, fuel oil, and lubricating oil, besides a number of by-products that society is glad to use, but generally indifferent as to their origin. Only the impossibility of obtaining the main products or a very considerable rise in price, can lessen the demand for these. Gasoline has no adequate substitute on a sufficiently large scale.* It has given us the most significant mechanical development of the century, the internal-combustion engine. The motor car is the most common example, the aeroplane the most sensational, of its many triumphs. Leaving on one side the convenience and the luxury of the one, and the teeming possibilities of the other with which our imagination is being tickled, this device for generating power in small movable units has had a remarkable development. The motor lorry is proving itself an efficient agent for short-haul traffic, and a competent feeder of the trunk railway. With renewed energy percolating through the agricultural activities of the country, the motor tractor will go far to displace the old-fashioned methods of hand and horse tillage, and help to solve the problem of shortage of labour. The motor van furnishes adequate facilities for transport, and finds a large field of usefulness in the prompt delivery of farm produce. The curtailment of such possible development by the want of petrol is only a small part of the loss on which we must reckon. The activities of all the trades engaged in producing automobiles and trucks, engines and motors, must be apprehended, if we would grasp what an inexhaustible supply of petroleum means to social progress and the industrial future of the community.

The familiar paraffin lamp, the outcome of the kerosene fraction, has provided the world with a cheap illuminant. The authors are justified in saying that "this commonplace substance has

* "The Mineral Industries of the United States—Petroleum: A Resource Interpretation," by Chester G. Gilbert and Joseph E. Pogue, of the Division of Mineral Technology, United States National Museum. Washington: Government Printing Office, 1918.

* A modern military aeroplane will consume about 20 gallons of gasoline an hour. The quantity of gasoline required for the American fleet now in course of construction will amount to several million barrels a year.

been America's greatest gift to the uncultured peoples of the world." Large centres of population have utilised more convenient, or more powerful sources, of illumination, but among scattered homesteads as among unsophisticated peoples abroad, paraffin forms the usual means of prolonging the business of life after sunset. A return to the gloom of the "flickering candle" cannot be contemplated without a shudder.

The diagram, Fig. 2, visualises the relative proportions of the oil consumed under the four heads we are considering. More than one-half is seen to be expended in the production of fuel oil, and this expenditure cannot be regarded with the same satisfaction with which one views the utilisation of the fractions that give energy to the motor and light to the world. In this country, coal has been wastefully used in steam raising, and the employment of fuel oil in the States for the same purpose must be regarded by economists with similar regret. But just as we find it impossible to adopt less costly methods, so in the States, and especially in the south-west portion, escape from this wasteful practice is hopeless. Messrs. Gilbert and Pogue sum up the faulty method trenchantly by saying "the possibilities of oil energised automotive agencies are so great and vital that before long it will be looked upon as inconceivable folly that oil should ever have been used for steam raising, the most glaring economic perversion that this country has ever been guilty of." It is to be feared, however, that the use of fuel oil is on the increase, especially where the stimulus of war industries has been active. Many manufacturers, finding coal difficult to obtain on account of deficient transport facilities, have had to fall back on oil fuel, but apart from momentary embarrassment or spasmodic activity, a marked tendency to shift from coal to oil has manifested itself. The consequence is that in the coming months a train of industrial disasters must be anticipated, disasters that may prove a blessing in disguise, if under the firm conviction that the supply is wholly inadequate to sustain the inordinate demand, more economical measures are adopted or enforced.

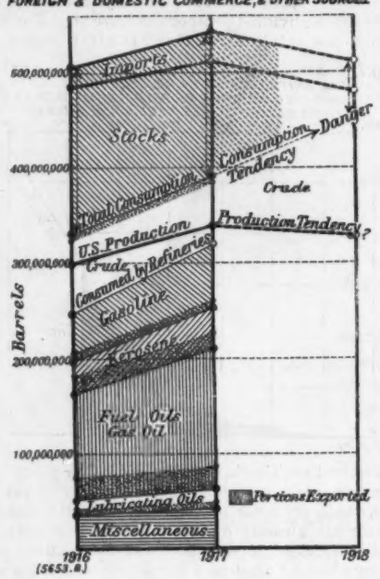
The diagram shows that only a comparatively small portion of the total output is consumed in providing lubricating oils, but it is an important contribution, for without this aid the wheels of industry would cease to revolve. Vegetable and animal oils are in use to a limited extent, but even if they were efficient in general employment, the quantity from these sources would be insufficient. Castor oil offers interesting possibilities as a lubricant, but it may be safely said that there is no satisfactory substitute for petroleum. When it is remembered that approximately half a pint of lubricating oil is used for each ton of coal converted into power, we glimpse something of the magnitude of the industry, and the difficulty of finding a substitute both cheap and abundant. The exhaustion of the main lubricant source is being accomplished with greater despatch than is justified by true necessity, and the engineering world must look to shale and coal to meet the threatened scarcity.

The space devoted to miscellaneous purposes is small but of special importance for it indicates the hopes and the opportunities of the future whose extent will be limited only by an inadequate supply of the raw material. The range of by-products to which petroleum contributes is already large and by no means exhausted. With sufficient scope for the display of further ingenuity and research, the world will be steadily enriched. The extent to which coal products have contributed to progress is admitted, but chemical skill applied to oil by-products promises a still more fruitful return. The trail is yet scarcely blazed, but enough is known to make the outlook hopeful and exhilirating. Any cause that operated to the curtailment of energetic exploitation of petroleum by-products must be regarded as a disaster.

If it be admitted that petroleum is essential to the world's welfare and that the onward progress of the future is imperilled by a reduced yield of oil and oil products, it is a matter of concern, even beyond the United States, where the symptoms of scarcity are more emphatically declaring themselves, to inquire if any and what steps can be taken to maintain an adequate supply. Increased capacity or an increased field of usefulness can be promoted in three ways: (I) "By prolonging the life of the unused portion of the domestic resources as it is now known; (II) by developing the low grade sources not yet drawn upon; (III) by building up the use of substitutes, particularly for gasoline, upon which a heavy and growing demand focusses."

The elimination of waste and the insistance on more complete extraction are the best means for securing a prolonged life, and there can be no practical difficulty in obtaining more satisfactory results, for petroleum technology is quite equal to the task imposed upon it. More technical research is not needed; what is wanted is authority to enforce the adoption of stringent, safeguarding measures. The authors, whom we are following in this account of American practice, compare the situation to that which would arise in a community that possessed an admirable code of laws without any provision for putting the same in execution. Be the explanation what it may, careful estimates

Fig. 2. THE CURRENT PETROLEUM SITUATION IN THE UNITED STATES. DATA FROM U.S. BUREAU OF MINES, U.S. GEOLOGICAL SURVEY, BUREAU OF FOREIGN & DOMESTIC COMMERCE, & OTHER SOURCES.



show that with the present practice, from 90 per cent. to 30 per cent. of the oil is left underground, and apparently in a form that is not likely to become recoverable. The loss above ground is not small, we have recently called attention in these columns* to the heavy loss due to evaporation in storage and the measures taken to reduce this amount by improved tank construction; but when the inevitable evaporation loss under the best conditions is added to that of seepage and of accidental fires, it may safely be affirmed that less than 25 per cent. of the petroleum underground reaches the pipe line. The loss does not end here. Wasteful methods of utilising the extract takes a heavy toll, and though, of course, no close approximation is possible, there is reason to believe that the final recovery factor is as low as 10 per cent. This figure, whils sufficiently alarming, is also hopeful, for it suggests that remedies might easily be found which will materially increase the percentage of extracted oil from existing fields.

In this respect may be usefully recalled the information given in two articles we have recently published† on the effect of infiltration of water into oil wells, and to the measures recommended for preventing the escape of natural gas when drilling,‡ for to these two evils, when uncontrolled, may be traced the origin of greatest waste. The occurrence of mineral oil is very similar to that of artesian water with which it is frequently associated. A typical example is shown in Fig. 3. A nice equilibrium between oil and water has to be maintained and the gas pressure may assist. Under uncontrolled conditions, an undue influx of water has not infrequently ruined a well and wrought irreparable injury to a whole field. The preventative is the construction of a watertight band of cement between the well casing and the water-bearing stratum. This precaution is now usually taken in California and Texas.

Petroleum generally carries immense quantities of natural gas in solution and under great pressure at depth. This gas may or may not be of great assistance in extracting the oil accordingly as it is judiciously used. Too frequently, it has been the custom when encountering this gas in drilling to suspend operations till the escape of gas relieved the pressure and allowed drilling to be continued with ease. The waste of gas from this method of working has been enormous and cannot be computed in precise terms of fuel. This needless waste is doubly harmful, for some of the lighter and valuable components of the oil are carried away with it. This loss is now fully recognised, and methods have been devised for recovering the volatile gasoline which when blended with a heavier petroleum distillate, furnishes the petrol of commerce. This gas, however, is not merely a vehicle for carrying away valuable products, but energy, which when properly conserved, facilitates the winning of petroleum by exerting pressure on the underlying gas (Fig. 3). A mud-laden fluid surrounding the drill hole has been found to be an effectual means of stopping the escape of gas. The folly of permitting and encouraging the escape of gas is shown by the fact that it has been found necessary to supply its place by compressed air. In some instances, an apparently exhausted well has been resuscitated by forcing compressed air down to the porous oil-bearing formation, the unextracted petroleum being forced to migrate to positions where it can be reached by pumping wells.

These are the main directions in which improved technique may relieve the petroleum situation and delay exhaustion of the basic product. We have next to consider the effect on the aggregate of the inferior use to which much of the oil is put. The problem here is not to get more oil from the wells, but to use the quantity available, much or little, in the most efficient manner. The coalfields of England present an analogous problem, but we have made little progress in solving it. America may prove less indifferent to economical operations. The relief is to come not from the oil driller but from the oil engineer and improved methods of distillation. The "cracking" process by which the molecules of asphaltic and the heavier component oil are converted into lighter molecules may be regarded as the hope of the future as regards refinery advance. Particularly, is it possible by having recourse to "cracking" to maintain the growing demand for gasoline, and so continue the expansion of the automotive activity, even though the production of the crude remains stationary or declines. But just as in this country, owing to the possession of abundant excellent coal, we have pursued extravagant methods for the production of power, so in the States with the command of apparently illimitable petrol, little attention has been paid to the more economical forms of internal-combustion engine. It is now urged, and apparently with good effect, that the Diesel type of engine using fuel oil or crude petroleum can be utilised for the creation of power on a large or small scale, effecting a great saving in gasoline without any loss of efficiency. The 7,000,000,000 barrels of petroleum, more or less, which the United States expect to raise from underground is definite and cannot be increased, but the useful power that the Diesel engine is capable of producing from this raw material is more than twice that given by the gasoline motor. The heavy oil engine by its improved efficiency practically doubles the available stocks, and will add enormously to the fuel resources of the States. The significance of the rich promise of this prospect seems at present to be only imperfectly realised. In marine engineering, a large field is open to American enterprise. The adoption and

* See page 303 *ante*.
† See Engineering, vol. cv, page 612.
‡ See Engineering, vol. civ, page 153.

development of the Diesel engine is the one means that will enable her to make the petroleum fields contribute to a wide extension in ocean traffic and the construction of a worthy mercantile marine.

Not much relief can be expected from importation, and whatever would be the temporary gain to America would imply a loss in the world's aggregate. One reads with some dismay that already Mexico is supplying one-tenth of the country's needs, and that the waning domestic output is compelled to supply its deficiences from foreign sources at a continually increasing annual rate. The discovery of fresh fields in Venezuela or Central America may delay, but does not avert, the impending catastrophe. The urgency of the domestic issue remains the same: the necessity of facing it is imperative.

A surer avenue of escape lies in the development of oil shales, and America is to be congratulated on the possession of a latent source of petroleum whose possibilities cannot be exaggerated. In Utah, Colorado and Wyoming, there is an abundance of black shales, that in the aggregate constitute an oil reserve that exceeds the original supply of subterranean petroleum. In Colorado alone the shales cover an area of 1,400 sq. miles, with an average thickness of 53 ft., whose exploitation will be conducted on as safe and sane a basis as in the coal mines of to-day. The steam shovel will replace the oil derrick, and oil mining will be the competent substitute for oil drilling. It is more pleasant to contemplate the dawn of a new industry than to lament the decadence of an ancient. From the eastern slopes of the Rocky Mountains to far into the interior of the Continent exist the elements of an industrial prosperity, to which the world knows no parallel. We are only concerned with the transition from oilfields to oil shales, and the competency of the latter to fulfil the function of the former. We may not travel away to the dazzling prospect offered by the occurrence of rich beds of phosphatic rock, abundant water power activating mechanical tillage, and inexhaustible supplies of fertilisers affording a food supply that will attract and satisfy a rapidly growing population.

Oil shales have been profitably exploited in Scotland and in other countries where the supply of petroleum is scant. There is no element of doubt in their successful working, and a basis of experience with an established technology is at the service of American pioneers. The Colorado-Utah shales, however, promise a richer return than those of Scotland, where a moderate financial success has been secured. This is indicated in the following analyses:—

General Comparison between Oil Shale of Scotland and of Colorado-Utah.

Average Yield from 1 Ton Oil Shale.	Scotland.	Colorado-Utah.	Use.
Oil .. .. gals.	24	50	Substitute for petroleum.
Ammonia sulphate lb.	34	17–25	Fertiliser: nitrogen products.
Gas .. .. ft.	2,000	3,000	Fuel.
Shale residue.. lb.	1,600	1,500	Brickmaking, roadmaking, &c.
Cost of production ..	1910.	1918.	
dols.	2·00	2·50–3·50 (?)	
Value of product ,,	2·80	3·25–3·75 (?)	
Profit per ton cents	80	75–25 (?)	

In 1917, the cost of a barrel of Pennsylvanian crude had advanced to about 3·75 dols., and it is estimated that a barrel of shale oil, of comparable quality, would cost about 4.20 dols., so that possible competition between the two sources is in sight. But though the output of the shale oil industry may compensate for the decline in the yield of petroleum, as a product of the oilfields, and remove the anxiety arising from the exhaustion of the latter, the possession of a second source will not excuse the wasteful misuse of the subterranean supply, either in methods of extraction or in the injudicious application of the several products. Whether the rival sources are to be run concurrently, or whether a stimulus such as would be derived from the visible exhaustion of the oilfields, is necessary to induce the American public to adopt a policy of eager development, we are not in a position to determine. But it is sufficiently obvious from experience in Scotland and elsewhere "that an oil-shale industry can come into effective action only as a large-scale engineering procedure, accumulating its profit from a narrow margin made significant by the magnitude of operations." The evil of the small holding, accompanied by uncontrolled competition is sufficiently manifested in the oil field areas to-day. It should not be repeated in oil shale mines. The methods encouraged or permitted by such minute subdivision must be held largely responsible for the premature decline of the petroleum supply. A competitive scramble has resulted; each driller or lessee endeavouring to reach and extract the oil with all expedition lest his neighbour should forestall him. The consequences must have been perceived in the early stages of the industry; only the more easily-gathered portions have been harvested, the remainder has been ruthlessly sacrificed. It was a fallacy to suppose that oil could be fixed in position, or right guaranteed by neatly-drawn lines indicating sections on a topographical chart, irrespective of geological units or natural limitations. Vertical boundaries that determined proprietary rights in coal or iron districts are unavailing in the case of a migratory oil, that invariably follows the direction of decreasing pressure. The fortunate prospector is ever at the mercy of unscrupulous or more energetic rivals. He may not delay production to ease an overburdened market, or restrain his output from prudential motives because "a rival operator with a neighbouring well will suck from under his feet the oil which his lack of action relinquishes. So long as the ownership of oil is determined by vertical boundaries . . . just so long will there be hurried production with all its train of losses."

These, however, are questions of fundamental domestic policy which one feels he has no right to criticise or discuss. They are only referred to here because it is evident that public opinion in the States is gravely exercised as to the adoption of the necessary safeguards that shall not restrict enterprise, or injure vested interests. In the words of the authors from whom we have quoted so largely and who have made a thorough investigation of the problem in all its important bearings, a constructive economic policy is needed "that would discourage unrestricted competition in production, provide for a tapering use of oil for steam raising, insure the development of petroleum by-products, and pave the way for the sound establishment of a shale-oil industry."

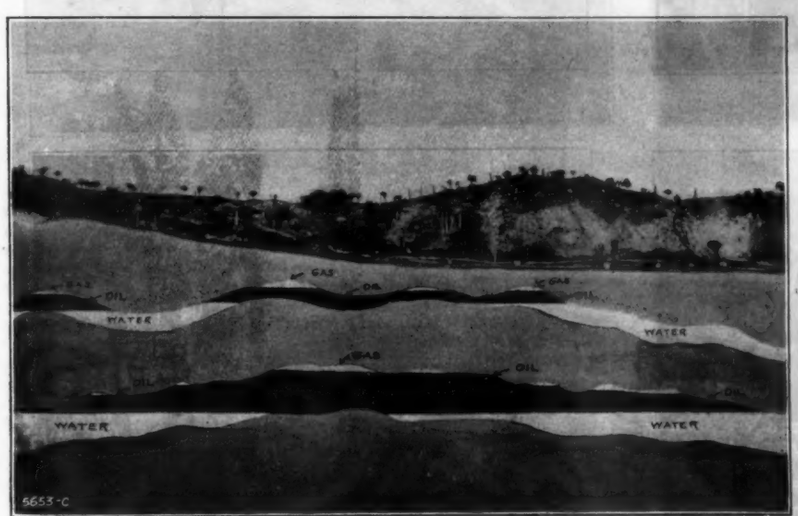


FIG. 3. VIEW OF THE OCCURRENCE AND MINING OF OIL AND GAS; PHOTOGRAPH OF A MODEL IN THE DIVISION OF MINERAL TECHNOLOGY, UNITED STATES NATIONAL MUSEUM.

TEMPLETS, JIGS AND FIXTURES.
No. XVI.

By JOSEPH HORNER.

IN the present article are given some examples of continuous milling carried out by the aid of fixtures designed by the Kearney and Trecker Company, of Milwaukee, Wis., U.S.A., and applied to the firm's "Milwaukee" milling machines.

In the illustrations on page 636, Fig. 499 shows a number of cutter blades of high-speed steel mounted on a fixture of a simple character. The only operation performed in this case is that of milling the clearance angle of 45 deg. on the upper ends, using an edge mill on a horizontal spindle. The fixture body is turned to that angle, slots are milled on the bevelled face to receive the blades, and studs for the clamp plates are tapped into it, one stud for each clamp. It receives blades from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. thick. The production is about 2,700 per day of 10 hours.

Fig. 500 illustrates push rods or tappets of the mushroom type for small automobile engines, having the flats milled on the ends with two straddle cutters set at the correct distance apart. A few rods finished are seen standing up on the table at the front. The rods are gripped in pairs in the fixture, one top clamp with a central stud bolt holding an adjacent pair. They are set radially by their turned shoulders in contact with the periphery of the fixture. The production is about 30,000 per day, but two men are constantly occupied in loading up spare fixtures for the machine attendant.

The milling of roller plungers, specimens of which are seen lying on the tables is the subject of the next illustrations. The first operation is performed in the fixture, Fig. 501. Its cylindrical body is pierced to receive the turned shanks of the plungers which are clamped down in pairs. The body is solid, the holes being drilled in it to receive the plungers. On the inner annulus it is shouldered down to permit the smaller diameter of the shanks to stand slightly above the face to allow a single clamp plate with a stud bolt to hold down two adjacent plungers. The convex-ended form is produced by the concave milling cutter. Afterwards the pieces are turned to right angles, Fig. 502 in the same fixture, when the slot is milled to carry the roll. The table of the machine, rotating slowly, the setting and release of the pieces is done by the operator without stopping the machine. He stands in front of the table, and as the pieces come round milled he takes out a finished plunger and replaces it with a rough one. This results from the simplicity of setting and gripping which is embodied in the fixture design, and that cannot be approached when pieces have to be packed up, adjusted, and bolted directly on

FIXTURES FOR CONTINUOUS MILLING.

CONSTRUCTED BY THE KEARNEY AND TRECKER COMPANY, MILWAUKEE, WISCONSIN, U.S.A.

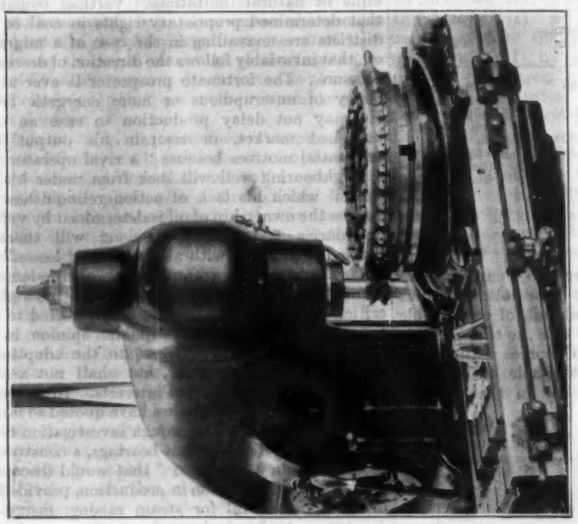


Fig. 501.

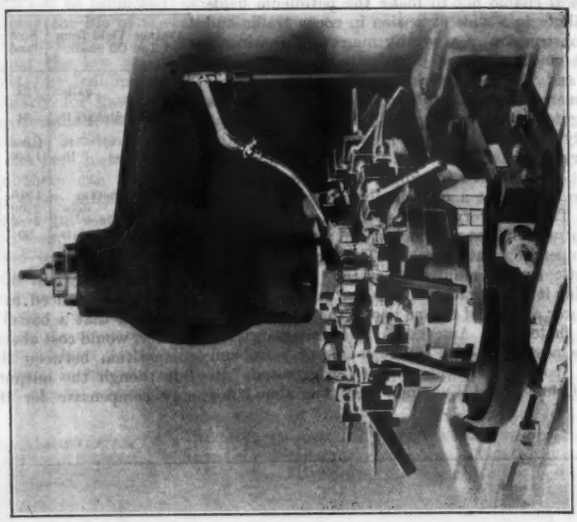


Fig. 504.

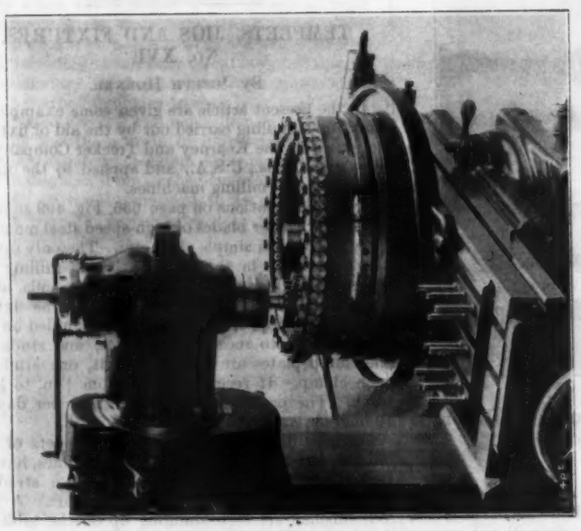


Fig. 500.

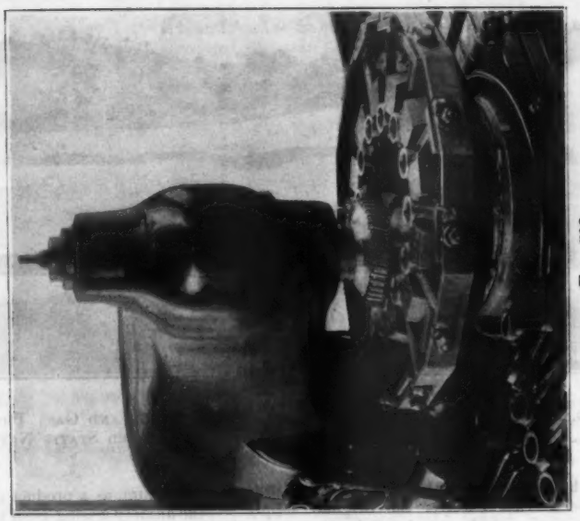


Fig. 503.

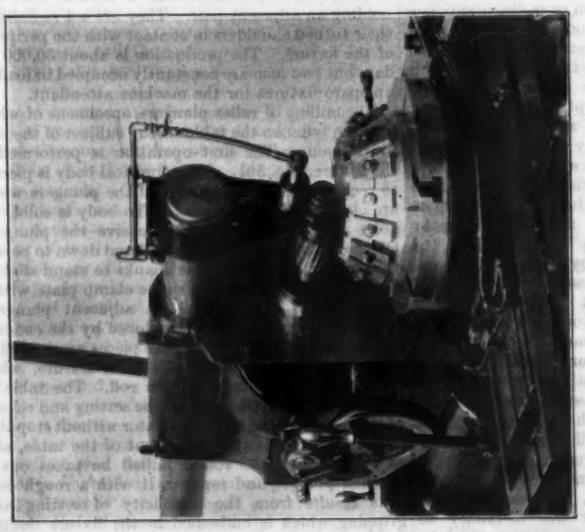


Fig. 499.

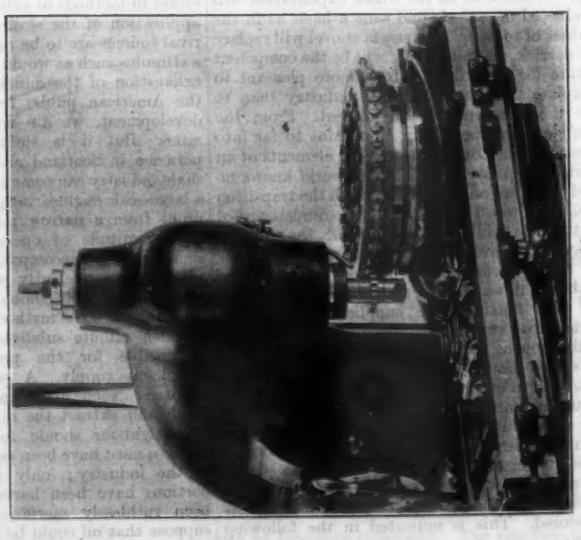


Fig. 502.

FIXTURES FOR CONTINUOUS MILLING.

CONSTRUCTED BY THE KEARNEY AND TRECKER COMPANY, MILWAUKEE, WISCONSIN, U.S.A.

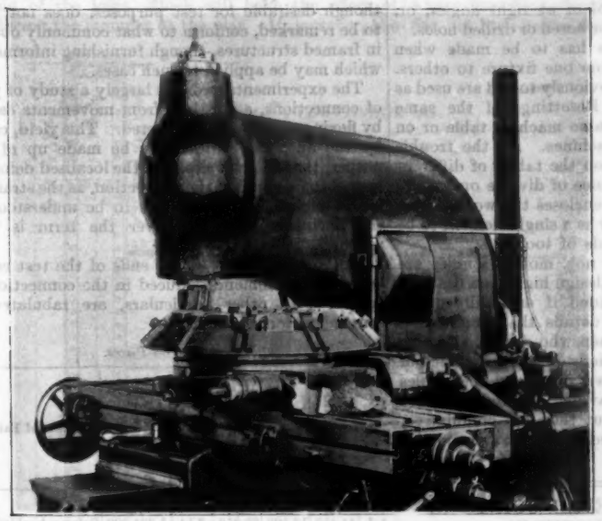


FIG. 505.

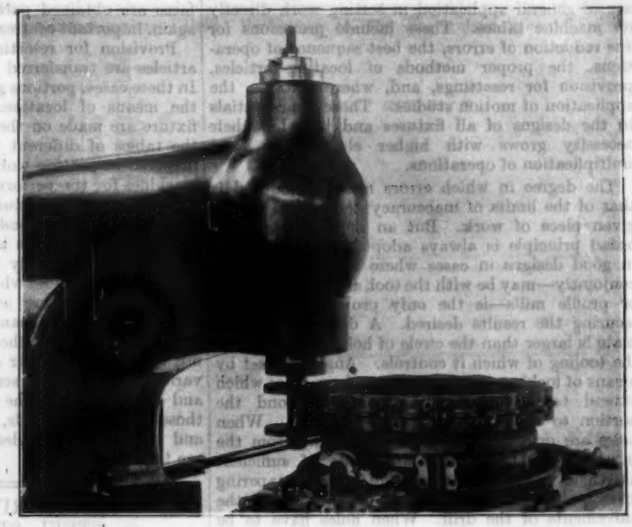


FIG. 506.

machine tables. This particular fixture is also of so simple a character that it is utilised for several other articles having diverse shapes by simply changing the clamp bolt holes and stops which take the pressure of the cut. Thus the expense of fixtures relatively to the cost of work produced is lessened. The Kearney and Trecker Company, who have these in use in their own works, say that in most ordinary cases continuous milling saves from 25 per cent. to 50 per cent. of time over that done on reciprocating tables with work arranged in series on string fixtures.

Fig. 503 shows a dozen connecting rods for small automobile motors being milled on their big-end faces. They are carried within a polygonal framing having locating blocks fastened down with cheese-head screws, to make contact with the big ends. The small ends project through openings in the vertical sides, and are clamped each with a plate against the inner portion of the boss, so pulling the big ends close to their locating abutment blocks. The production of rods is 2,500 in 10 hours. The face mill used has inserted teeth of high-speed steel.

The next fixture, Fig. 504, has a rather elaborate appearance. It is used in the facing of the sides of the jaws of monkey wrenches—adjustable spanners—one of which is seen lying in front on the table. The solid jaw is a steel forging, the adjustable jaw is a malleable iron casting. The wrenches are laid in the openings provided for them, the jaws facing inwards to come between the opposed faces of the straddle milling cutter which tools both sides of the jaws simultaneously. The wrenches are each held down with an eccentric clamp, the levers of which are seen sloping downwards, the eccentric camshaft being supported in the uprights that flank the levers. The pressure of the cut is taken against the stop pins that stand up between the uprights. The work is held solidly, and the cutters are lubricated. A production of 3,000 wrenches per day is recorded, being 50 per cent. more than had been previously obtained from three Lincoln type milling machines.

Two photographs, reproduced in Figs. 505 and 506, on the present page, show the milling of bearing caps for automobile crank-cases. An output of 5,000 pieces a day is secured off both fixtures. In the first the joint face is milled, the second deals with the sides. This is work that is being largely done on the disc grinders which are not so costly to instal as the milling machines are, but the results are not so precise, nor is the production so large.

In the fixture, Fig. 505, the caps, two of which are seen on the table at the front, are supported on stout pins in the fixture body, which locate the height for uniform facing. The caps are each held with a single bolt, and a U-clamp, the end of which lies in the concavity of the cap. A solid face milling cutter covers the width of the jointing faces of the caps. In the second fixture, Fig. 506, the cap faces just tooled are abutted against the periphery of the fixture body, to which they are gripped, each with two bolts at cross corners. Two straddle milling cutters deal with the upper and lower faces of the caps at the same time.

The examples hitherto given in their multitudinous wealth of detailed design have borne testimony to the fact that jig and fixture work is not one of rule-of-thumb practice. It is not only a task involving very fine degrees of precision, but each individual design has to be carefully thought out. While it is a matter of cost—of relative expense—it is also one, an object of which is to evolve a scheme which secures the necessary degree of accuracy with the elimination of unnecessary complications. Though many of the examples illustrated may have appeared intricate and very expensive, especially to old-time machinists, yet assuredly they have been the simplest in the well-balanced opinion of the designers that the controlling conditions would permit of. One wonders sometimes when studying some of these, how many alternative schemes have been outlined and scrapped before the final design was evolved and settled on. Especially must it be so when articles have to pass through more than one fixture. While several distinct operations may be included in one jig fixture, as often several are required to deal with the varied work done on a single piece. Much preliminary outlining and general planning necessarily precedes the working out of final details. Ideas have to be discarded in consequence of their unworkability, or their excessive cost. The special experience and minute knowledge required have called into existence the jig and tool draughtsman.

Accuracy here, as in all departments of manufacture, is a term to be used in a relative sense. To insist on and embody finer-gauged limits than are necessary for the character of the work done is wasteful, because with every stage of refinement the cost increases. The fittings of cranes, of contractor's plant, though manufactured in large quantities, are not of so high a grade as those of machine tools, or of automobiles and engines, or small tools, or parts of munitions, as fuses. And in these there are degrees, since parts which are not mutually fitting need not be gauged so finely as those that are.

Cost is also related to the total numbers of pieces set up and tooled. Savings are estimated in minute sums—in pence, or even in many cases in fractions of a penny per piece. Operations are often extremely restricted, as a hole drilled, or a surface tooled, a roughing cut, or a finishing cut. The cost of the fixture or jig has to be weighed against the time saved by its use, which resolves itself into a question of the numbers handled. The larger the product the more money can be spent in perfecting the fixture or jig. But it must be less than the amount saved by its use, and it should be very considerably less. There is little difficulty in maintaining a due balance when the number of articles tooled in a day runs into the thousands, and the manufacture is standardised over almost unlimited periods.

In some instances a fixture is essential even though the product is numerically small. It is so in all those cases where holes, or surfaces, or notches have to be accurately pitched or indexed, since however small the numbers required are, hand-dividing is now nearly unthinkable. Even apart from fixture making, division plates of various forms are used on machine tables. Fixtures of this kind may be constructed simply, or they may be elaborated chiefly with a view to increased durability in service. Herein lies one of the differences between the cheaper fixtures of cast-iron or steel with plain holes or notches, and those in which tool steels are used for bushes and pins, case-hardened, and ground, and these again fitting in hardened lining bushes.

In fixture and jig work as in articles manufactured without their aid, costs are estimated readily if the system is adopted of recording all the individual items. Something of this has been obvious in many of the detail drawings previously given. But the original shop drawings include many references to standardised parts; screws, pins, and so on, taken out of stores by their numbers or letters, with suitable references to their locations on the drawings. This practice in conjunction with the charging of time by the jig and tool draughtsman, and by the workmen, enables an exact knowledge of the cost to be arrived at. The looking-up of past records of this kind is also helpful when other fixtures and jigs of not very dissimilar characters are being planned. The standardisation of the smaller and most frequently recurring fittings facilitates the getting out of estimates, and reduces the numbers of variations in the elements, which would otherwise be multiplied out of all reason. This is but an extension of the practice of standardising the loose fittings used by machinists for holding work directly on tables—the clamps, packings, bolts, vees, vices, angle plates, machine

centres, and so on, which are as essentially fixtures as are those to which the term is more specifically applied.

The designing of fixtures and jigs proceeds along well-defined lines, and is based on principles which are of general application in setting work directly on machine tables. These include provisions for the reduction of errors, the best sequence of operations, the proper methods of locating articles, provision for resettings, and, where suitable, the application of motion studies. These are essentials in the designs of all fixtures and jigs, but their necessity grows with higher elaborations, and multiplication of operations.

The degree in which errors must be reduced is that of the limits of inaccuracy permissible in any given piece of work. But an application of the broad principle is always adopted, and embodied in good designs in cases where the fixture or jig conjointly—may be with the tool, as in straddle mills or profile mills—is the only provision made for securing the results desired. A division or index plate is larger than the circle of holes or of notches, the tooling of which it controls. Angles are set by means of locking arrangements, or from faces which extend to a considerable distance beyond the portion to be tooled in angular relations. When holes are drilled at some distance away from the faces of jigs the bushes are made of sufficient length to meet the faces, being often of tapering form on the outside to ensure rigidity under the movements of the drill. When holes have to be both drilled and reamed it is nearly invariably the practice to use the same jig by changing the bushes for drilling and reaming. This seems more safe than attempting to make two distinct jigs with a number of holes, the centres of which must be precisely alike. When practicable, a hole already drilled or reamed is made the medium of assisting the exact location of another in the same axis, by the employment of a pilot pin at the end of the boring bar, or the reamer. This is an application of the sound general principle of making one operation a guide for the location of a second one, which is freely adopted when bores of different diameters lie in the same axis. Sometimes the larger bore may be done first, or the smaller according to which happens to be the more convenient or necessary. The principle has many other applications whenever second or third operations are located from that first done. The first may be a face tooled, or an external portion turned and used for subsequent settings. If the locating surface is only a "spot" facing, or some rough external portion, then the first actual tooling is utilised for resetting for subsequent operations.

The sequence of a series of operations follows naturally from the foregoing principles, whatever their character or their number. These may be of major or minor kinds, dimensions of greater or lesser importance, parts which must interchange, or those which do not fit to any other part. And though rough external faces may be used for spot locating they are of no further use after the first tooling has been done. For consecutive operations economy would suggest the multiplication of toolings in a single fixture. Yet the best results are often secured by increasing the number of fixtures of a simple character between which the work is transferred, rather than multiplying complications in one. Alternatively there is the design of compound fixtures, the base—the main element in which receives successively subsidiary attachments. The advantage of employing these is that they prevent excessive accumulations of massive fixture bodies in the tool room or the stores. In many cases they may slightly favour accuracy, because the piece of work remains as it was first set instead of being moved into different fixtures.

The proper location of pieces concerns not only the individual article, but the thousands of similar pieces that have to be tooled. These are castings or forgings that frequently vary in dimensions, sometimes by considerable differences. At an early stage therefore the best method of locating these in the fixture has to be settled. Many are hollow forms, either cored or stamped, and the holes may be inaccurate relatively to the external portions. Symmetry, correct thicknesses of metal after tooling, must be ensured. Work of this kind is generally located by the rough cast, or forged exterior, by means of a stud or studs, a vee, or a fork, self-centering. Often a location of this kind is associated with that of a plain-faced surface, whence other faces are obtained parallel or at right angles, or, again, important centres for bored or drilled holes.

Provision for resettings has to be made when articles are transferred from one fixture to others. In these cases, portions previously tooled are used as the means of location. Resettings of the same fixture are made on the same machine table or on the tables of different machines. All the trouble involved in putting work on the tables of different machines for the performance of diverse operations is avoided when a fixture encloses the work, which can be moved about bodily as a single element to be dealt with by various kinds of tools.

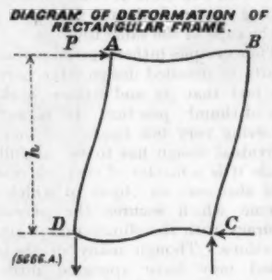
Whether consciously or not, motion studies are in the minds of those who design high-class fixtures. Two movements are avoided if one will suffice. This is evident in many details that might pass unobserved, save by the men who design, and who use them. They occur chiefly in the fastenings of various kinds—bolts, screws, nuts, and their holes and attachments. The savings effected are only those of a few seconds, but they are cumulative, and must not be neglected if the last economies are to be secured.

RIGIDITY OF RIVETED JOINTS OF STEEL STRUCTURES.

The above title indicates the subject of an inquiry conducted at the Engineering Experiment Station of the University of Illinois, the results of tests, and of analysis based on these tests forming the subject of Bulletin No. 104, lately issued.

Before proceeding to consider this issue in detail it may be well again to draw attention to the valuable work being done under the auspices of the Board of Trustees, who established the station in 1903.

Fig. 1. DIAGRAM OF DEFORMATION OF RECTANGULAR FRAME.



Since that date a variety of questions has been dealt with, chiefly of interest in Structural Engineering, though including such matters as High-Speed Tool Steel, Fuel Tests of Coal, Transmission of Heat through Locomotive Boiler Tubes, the Thermal Conductivity of Fireclay, Acoustics in Auditoriums, and other questions—the whole forming a most valuable series.

The bulletin now to be considered has been prepared by Wilbur M. Wilson, Assistant Professor of Civil Engineering, and Herbert F. Moore, Research Professor of Engineering Materials. The purpose of the inquiry has been to determine the rigidity of riveted joints which connect the members of steel-framed structures, and by analysis to ascertain the effect of defective rigidity upon the stresses of a closed frame subject to a distorting force P (see Fig. 1.)

Connections of six types were tested, in duplicate, illustrated by Figs. 2 to 7. The first two are such as would be expected in ordinary work to give end fixity. The fourth—A_4—such as would, by reason of eccentricity of attachment, not be expected to give complete rigidity, and the three others—A_3, A_5 and A_6—connections which in structural design would be expected to do no more than accept vertical shear. In all these, however, there is, it must be evident, some rigidity, whether or not it be desired. Each pair of test specimens was mounted on the table of a 300,000-lb. Olsen four-screw testing machine as shown in Fig. 8, page 640, which gives also some idea of the methods used for determining angular, or "slope" quantities. It will be noticed that by the method of test adopted, the moment to which the connection is subject, is always a definite amount, the product of the load applied, and length of lever arm. This, though desirable for test purposes, does not, it is to be remarked, conform to what commonly obtains in framed structures, though furnishing information which may be applied to such cases.

The experimental work is largely a study of yield of connections, as distinct from movements caused by flexing of the parts connected. This yield, called by the authors "slip," may be made up of slip proper, that is, rivet slip, and the localised deformation of some detail of the connection, as the straining of an angle bar cleat, and is to be understood in this inclusive sense wherever the term is used without qualification.

The loads imposed at the ends of the test cantilevers, with moments induced in the connection at failure, with other particulars, are tabulated in convenient form as under:—

Loads on Test-Pieces.

Test-Piece.	Load at Failure on One Girder.	Working Load.*	1.5 Times Work-Load.†	Load at Failure Divided by Working Load.	Moment on Connection at Failure.	Manner of Failure.
	lb.	lb.	lb.		lb.	
A 1	44,450	17,500	26,250	2.54	5,334,000	Column buckled.
A 2	37,500	18,540	27,800	2.02	4,500,000	Gusset plate buckled
A 3	10,250	3,030	4,545	3.38	537,000	Lug angle opened.
A 4	13,550	5,000	7,500	2.71	570,000	Column buckled and angle opened.
A 5	19,000	3,400	5,100	5.59	1,860,000	Connection angle opened, rivet failed in tension.
A 6	11,250	2,750	4,125	4.10	506,000	Connection angles opened.

* Based upon—axial bending stress, 16,000 lb. per sq. in.
shear on rivets, 12,000 lb. per sq. in.
bearing, on rivets 24,000 lb. per sq. in.
† Corresponding to allowable working stresses for wind loads.

The results of observations have been plotted, together with calculated quantities (slopes) in such a manner that the difference between the two curves shows the effects of slip. It should, however, be stated that in making computations for slope it was assumed that the section of members is uniform up to the intersection of their centre lines, so that the difference between the two curves, is not in some cases wholly due to slip. Results for test pieces A_1 are reproduced in Fig. 9, which should be read with the index diagram Fig. 8, showing the points to which the results relate. These results though enabling useful conclusions to be drawn with respect to actual cases, do not indicate an invariable relationship of actual to calculated strain, as this relationship is affected by the position of the points examined relative to the point of intersection of the members. Significance of the facts observed, as affecting practical cases cannot indeed be appreciated till examination of such a case is made with the assistance of the facts disclosed. This the authors do by analysis of the effects in a closed rectangular frame (originally unstressed) subject to a horizontal force applied at the top, and supposed to be 15 ft. high, by 20 ft. wide, to ascertain for this case what errors may be involved by the assumption of rigidity at the connections, where but some degree of rigidity truly obtains. By somewhat elaborate reasoning it is shown that for such a closed frame, slip alters moments only when unequal at the four connections, for equal slips being as for connections of strict rigidity. That this is so is manifest, as if the slip of each connection is equal, slip having been eliminated, the frame will then behave as one having rigid connections. This will be true in the result, provided the slips be ultimately of equal amounts, even though slip does not occur at all connections at the same rate. There would, however, be difference of moment at any stage of stress development at which difference of slip obtained, a statement consistent with the investigators' conclusions. Ultimate difference of slip has on the contrary the effect of inducing deviation from results to be expected from rigid connections, or from connections developing equal slips. The case of unequal slips may be compared to the somewhat simpler case of a girder continuous

over three supports, with a joint over the mid pier. The moment at the pier, will, for perfect continuity, and bearings unyielding, be of a definite and ascertainable amount, but liable to modification by any yield of the joint, which will have the effect of reducing the moment at the pier. If, however, the the importance or otherwise of slip at connections is greatly affected by the stiffness of the members. Slip which may be of small importance in cases where the members are distinctly flexible, may have a very disturbing effect in the case of members which flex but little. For this reason investigation of the no material error, but that the same assumption for types A_3, A_4, A_5 and A_6, introduces errors of such amounts as to make it apparent that these must not be considered as giving fixity, though A_5 has for low stresses, a considerable measure of this.

Reverting to the particulars given here for

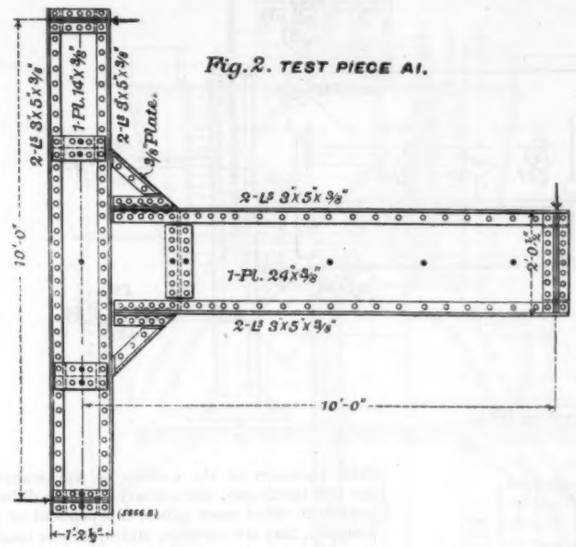


Fig. 2. TEST PIECE A1.

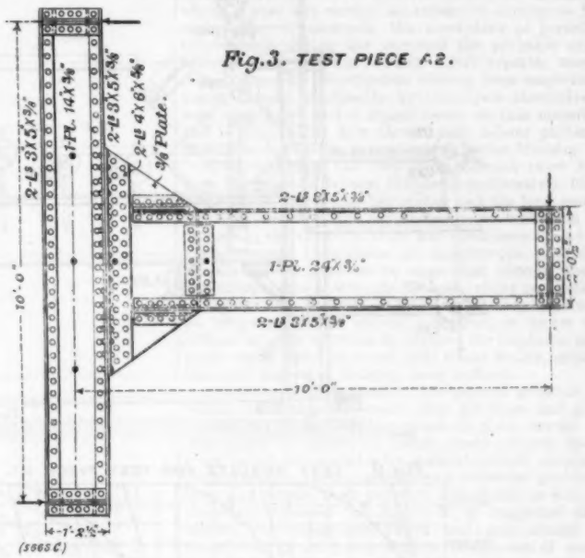


Fig. 3. TEST PIECE A2.

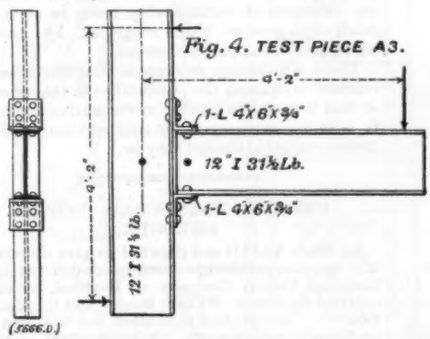


Fig. 4. TEST PIECE A3.

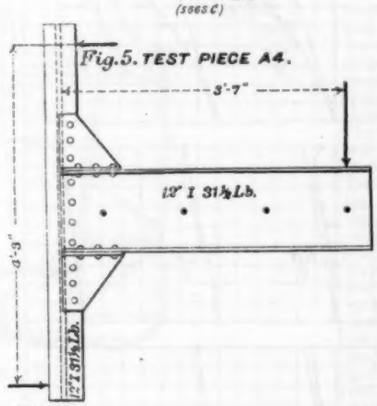


Fig. 5. TEST PIECE A4.

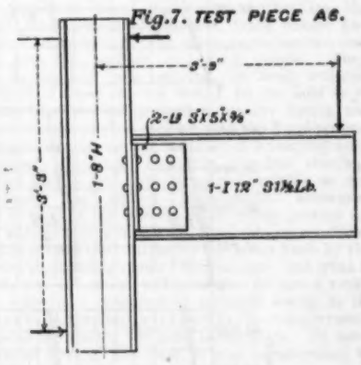


Fig. 7. TEST PIECE A6.

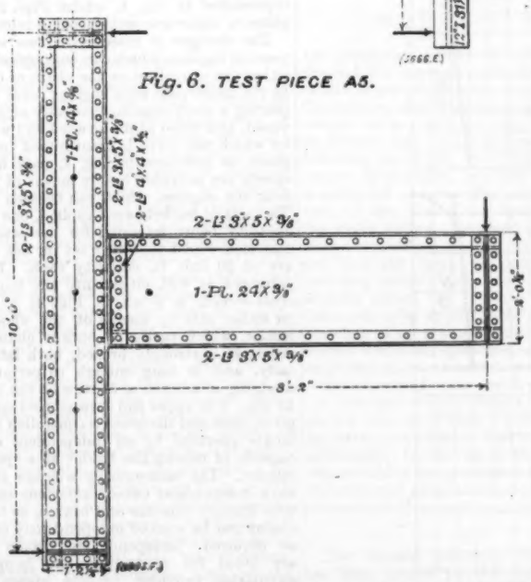


Fig. 6. TEST PIECE A5.

outer bearings yield also, an amount conformable to the joint yield, this moment may remain unaltered, as in the case of the closed frame with equal slips at connections.

Other test results are treated by the investigators in the same manner as are those for the A_1 test. It must be evident, as shown by the authors, that imaginary but practicable frames assumed by the authors, is made to include members of different degrees of stiffness, in the endeavour to reach percentage error results which shall be instructive to those interested in the branch of design dealt with. The broad conclusion is that for connections of types A_1, A_2, the assumption of rigidity leads to type A_1, it is to be expected that observed results on either side of the vertical web joint in the cantilever should be materially in excess of those calculated on the basis defined, at the point near the column, because the full section of the cantilever does not extend to the axis of the column, as presumed, and at the point farther removed, for the same reason, and because of rivet slip at the joint.

At the point below the upper horizontal web joint of the column a closer agreement may be expected, the full section of the column being undiminished, and at the point immediately above this joint, no greater discrepancy than that due to slip of joint rivets.

Examination of the curves in Fig. 9, will show them to be consistent with these comments. The admitted error in the calculation for slope at the point in the cantilever nearest the column has the effect of making this slope appear smaller than it should be, that is, the calculation indicates somewhat greater rigidity than a more strict computation would present, but it is to be remembered that the inquiry appears to be intended to show how the observed results compare with computations based on usual assumptions, whether right or wrong.

The discussion of the experimental results has been limited to the case of a rectangular frame subject to horizontal forces such as occur in wind braces of a steel-framed building, but it must not be imagined that the results reached may be applied to a framed structure under load, the beams flexed, and slip of connections already developed, the conclusions being true only for a frame initially

unstressed and undistorted. For such a combination of effects, elucidation would no doubt be extremely involved. The results of the inquiry will, however, be found of value in considering other cases occurring in practice, and it may be well further to emphasise the important bearing that relative stiffness of girder and columns have upon the function of an end connection, for no matter how rigid this may be, if the column is flexible in any material degree, there may be in effect no sensible fixing of the girder end. Further, though slip at the connection of the simple closed frame considered by the authors does not, if equal, modify moments, yet this is not so, of necessity, in the case of a beam carrying load, connected to columns, for if the slope at the beam end is for the simple beam, less than slip of rivets permits, the full moments due to rigidity of connections will not be developed, unless slip occurs only at moment equal to, or greater than, this. Examination of the curves makes evident considerable difference in the slips observed in cases where these should be the same, suggesting some little variation in the quality of workmanship in the test specimens, particularly as these differences include in some cases effects independent of workmanship, that are common, and equal—or nearly so, the influence of workmanship being in such cases relatively greater than suggested by any dissimilarity of comparable curves.

There is no reason to suppose that the differences referred to exhaust the possibilities in this direction, so that it would be unwise, as the authors point out, to base too much upon the limited number of tests made—valuable though they be.

Fig. 8. MEASUREMENTS OF ROTATION FOR TEST PIECE S AI

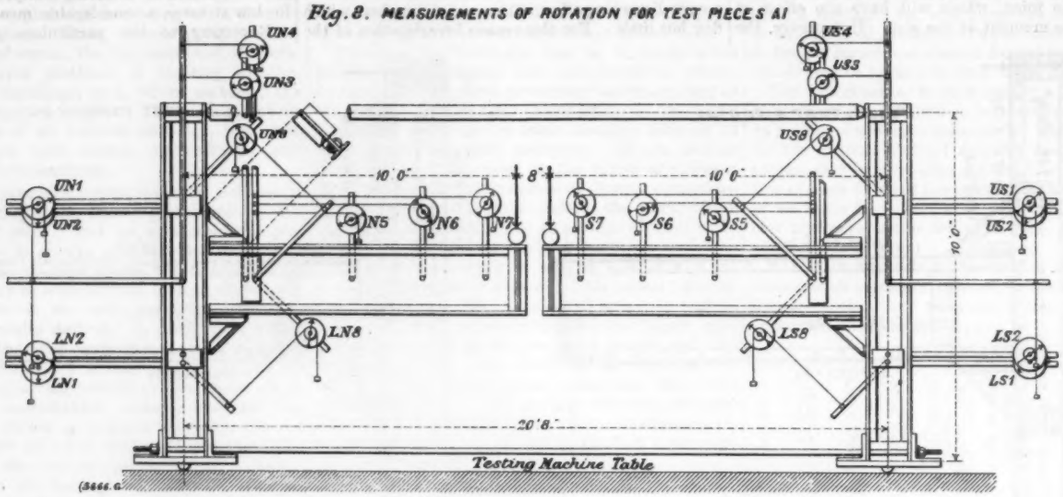
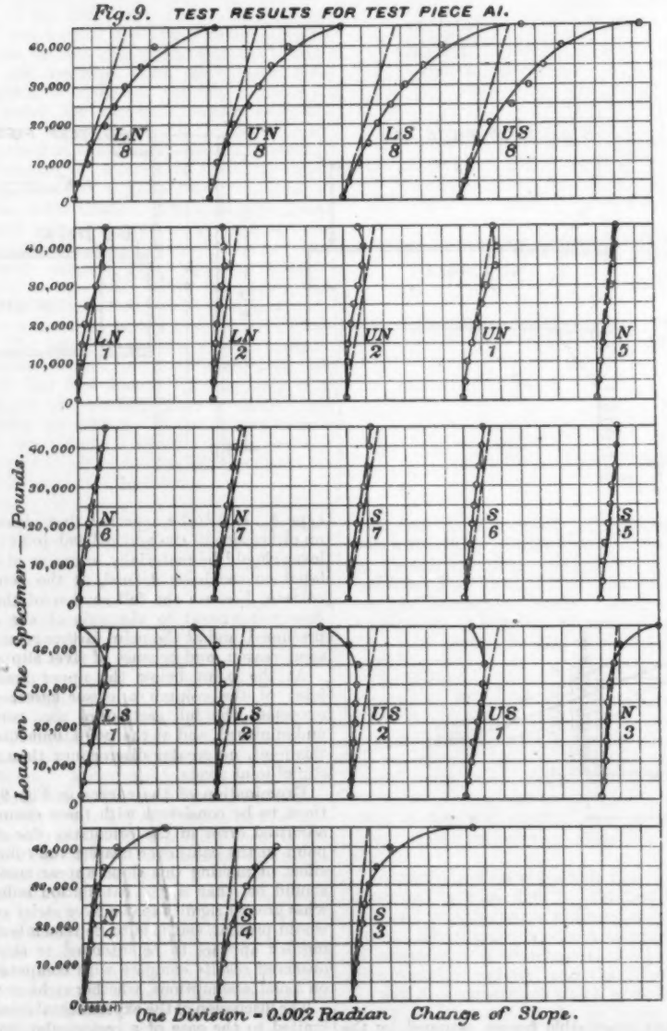


Fig. 9. TEST RESULTS FOR TEST PIECE AI.



1,500-TON TWIN-SCREW HOPPER DREDGER.

On Plate XLVIII and page 641 we give illustrations of a large hopper dredger recently constructed by the Canadian Vickers Company at Montreal, to designs supplied by Messrs. William Simons and Co., Limited, Renfrew. The dredger is of steel, and has been built to Lloyd's requirements. A longitudinal section is represented in Fig. 1, whilst Figs. 2 and 3 are deck plans, a transverse section being represented in Fig. 4.

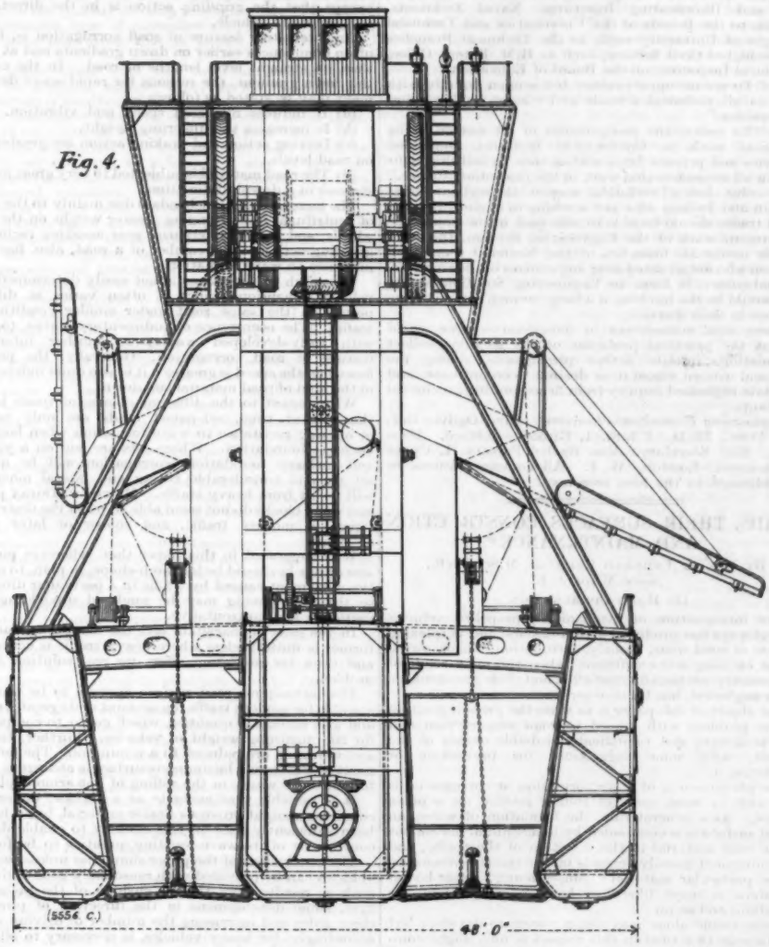
The dredger is fitted with two sets of triple expansion engines, which can be coupled up so as to drive either the propellers or the chain of dredging buckets. In the latter case both engines drive by double helical gearing a shaft running centrally along the hull of the vessel, and fitted at its forward end with a bevel wheel by which the drive is transmitted to the ladder head gears, as best seen in Fig. 4, page 641. Two ladder speeds are provided for by means of the change gears near the engines, which can be seen in Figs. 1 and 2. Two sets of buckets are supplied, one set of 54 cub. ft. capacity being intended for use when dredging soft material, whilst the other set for use on stiffer ground are of 30 cub. ft. capacity each. The spoil can be delivered at will, either into the hopper (of which a cross-section is given in Fig. 4) or else into barges on either side by means of the shoots shown. The ladder, which carries a bucket chain of exceptional strength, is strongly braced, both laterally and vertically, and is long enough to permit of the buckets dredging at a depth of 57 ft. with the ladder inclined at 45 deg. The upper end is supported on an independent pivot shaft and the lower is controlled by steel wire rope tackle operated by an independent engine, which is capable of raising the ladder at a speed of 10 ft. per minute. The manœuvring winches at bow and stern have independent two-cylinder engines and are fitted with friction clutches and brakes, so that the mooring chains can be worked independently or simultaneously as required. Independently driven steam winches are fitted for controlling the hopper doors. The auxiliaries provided include steam steering gear, electric lighting plant and refrigerating plant. The steam supply, both for main engines and the subsidiaries is provided by two marine boilers designed for a working pressure of 180 lb. per square inch. Each is large enough to furnish steam simultaneously for one of the main engines and for the whole of the auxiliaries.

1,500-TON TWIN-SCREW HOPPER DREDGER.

CONSTRUCTED FROM THE DESIGNS OF MESSRS. W. SIMONS AND CO., LTD., RENFREW.

(*For Description, see opposite Page.*)

Fig. 4.



INDUSTRIAL NOTES.

A SYSTEM of payment by results was instituted by Messrs. Priestman Brothers, at their Holderness Foundry, Hull, on April 1, 1917, for the duration of the war. It is based on the following principle: If a given number of men in a given time are capable of producing on the ordinary method of day-rate working a certain quantity and type of finished machinery—called the "standard output," then if by greater collective individual effort, *i.e.*, without increasing the number of men, or without working any longer hours per man, they can increase the output of such machinery, it is possible to advance their total day rate wages by a percentage equivalent to that by which the standard output has been increased. As Messrs. Priestman state, a very important point is to settle a standard output which may be fair both to the employers and to the employed. After careful investigation, it was considered that a standard of "average weight" should form the basis for the introduction of the system in their works, and by agreement with representatives of the men, a certain weight of completed machinery packed and despatched per month is accepted as the standard unit. The standard is an average of weight of work delivered per lunar month comprising the whole of the machinery which leaves the works; it is based on the number of workmen and apprentices employed and the average number of hours worked at the beginning of April, 1917, with overtime. The standard weight is not altered so long as the number of men employed, the number of hours worked and the plant utilised remain substantially the same as those on which the scheme is based. The agreement provides that the standard weight is to be modified to bring it into line with alterations, if the number of men employed and the hours worked, or the method of manufacture vary appreciably. If the output falls below the standard it has to be brought up to it before the percentage for excess output is determined. At the end of every four weeks the output in tons for that month is posted up, after being verified by the Works Committee, and by as much as it exceeds the standard output, by so much per cent. are the earnings of each employee—man or apprentice—increased for the four following pay days. In addition, men and apprentices receive 10 per cent., whether the fixed average wages is exceeded or not. The weekly wage is the agreed rate of the Hull Iron Trades Association, and of the trade unions concerned in the scheme. A very close examination into the output now being obtained per man per hour, as compared with the corresponding output prior to the introduction of the scheme, shows the increase in the weight of work delivered to be approximately 40 per cent. Provided the class of work being manufactured is kept approximately constant, provided also the number of men employed and the hours they work—the "man-hours"—do not exceed those which are worked in arriving at the standard weight output, then the cost of labour per ton is no more than it would be under the ordinary day rates of working. The scheme, it is stated, gives satisfaction to the men, their foremen and trade unions, and is being continued. Its extension to other works should go far to help the problems of demobilisation and readjustment now before the country.

The Central Advisory (Port Labour) Committee has been formed by the Minister of Labour for the purpose of advising the Minister on general questions relating to labour in the ports, co-ordinating the work of the Local Port Labour Committees, and allocating the pivotal men to be released from the Army, for work in the ports, to the different ports claiming their services. The appointment of a secretary will be announced in due course; communications should meantime be addressed to Mr. E. C. P. Lascelles, Ministry of Labour (Demobilisation and Resettlement Department), 8, Richmond-terrace, Whitehall, S.W.1.

In view of the widespread distress and demoralisation that would be likely to arise if the many boys and girls under 18 who, during the war, have been engaged in industry were thrown haphazard on to the labour market, the Minister of Reconstruction, Dr. Addison, about a year ago caused an extensive inquiry to be undertaken to ascertain the conditions of juvenile employment during the war and the probable conditions after the war. Fully 3,000 reports, made either by special investigators visiting firms employing young people, or directly by employers themselves, were considered, and a report based on this material and recommending how the juvenile labour problem should be dealt with, is now issued by the Ministry.

After describing the very great demand there has been for juvenile labour, the disproportionately high wage which this labour has earned and the long hours frequently worked, the report makes no hesitation in describing the effects of these war conditions upon the young people themselves as mischievous and demoralising. It goes on to urge that though these mischievous effects wrought upon the rising generation of the last four years cannot be effaced, they need not be intensified. The nation, moreover, is under an obligation to do all it can to improve the condition and prospects of these boys and girls whose health, education and industrial training have suffered.

A scheme is recommended, the general principle of which, briefly, is to ensure that all boys and girls thrown out of work on the return of peace, should be maintained in conditions which would prevent them from being demoralised by unemployment, improve their physique, their character and industrial qualifications and prepare them to return to industry as soon as there are suitable openings. It is suggested that centres for unemployed boys and girls should be established in all towns with a population of more than 20,000. They should be managed by committees drawn from the Local Education Authorities, the Juvenile Employment Committee, trade unions and employers' associations, and other organisations concerned with the welfare of young people. They should be financed from national, or local, sources. The object of these centres would be to hold boys and girls together under good influences during unemployment and in close contact with the Employment Exchanges, and to use the interval of unemployment for further education, including physical training, organised games, and such industrial training as can conveniently be offered. Maintenance allowance should be paid to the parents of all young persons for whom work is not immediately available on condition that they attend the centres for the hours fixed by the authority controlling them. Special care, and what is virtually a re-education, will be needed for many young people who have deteriorated seriously owing to ill-health or to demoralisation caused by their employment and social life during the past three years. To meet the case of boys of this class, it may be necessary to establish residential camps.

The report, which makes a complete survey of the whole ground of "Juvenile employment during the war and after," will shortly be available from H.M. Stationery Office, price 2*d*.

The secretaries to the Midland Iron and Steel Wages Board have issued the report of the accountants for the two months ended September and October last, and have announced that the wages for puddling during the present month of December and the month of January next will be 19*s*. 9*d*. per ton, and that all other forge and mill wages will be advanced by 5 per cent. The 19*s*. 9*d*. is made up of 18*s*. 9*d*. per ton in accordance with the sliding scale and 1*s*. per ton on puddling, or 10 per cent. on all other forge and mill wages as the equivalent of subsidies on pig-iron. The new wages will take effect from Monday next, the 9th inst., and will continue until Saturday, February 1. In addition to the 19*s*. 9*d*. per ton, there is to be 6*d*. per ton bonus granted to the puddlers by resolution of the Wages Board which met on July 15, 1912; this applies to puddlers only and makes the total puddling rate 20*s*. 3*d*. per ton. The average net selling price of bars, angles and tees, plates and sheets, hoops, strips and miscellaneous for the two months in question was 16*l*. 9*s*. 7·62*d*., as against 16*l*. 1*s*. 1·63*d*. for the preceding two months.

The cotton mills in Lancashire and in the adjoining counties are to be closed next week if in the meantime no settlement is arrived at between the employers and the operatives in the matter of wages. The Board of Trade have closely followed the dispute, and Sir George Askwith went to Manchester last Wednesday to meet the cotton-weaving section of the trade and probably also the cotton-spinning section. We understand that a private meeting of the Spinners' Federa-

tion, the employers' association, was held last Tuesday in Manchester, under the chairmanship of Mr. Percy Ashworth; it was stated that at this meeting a resolution was approved commending the action of the sub-committee in not agreeing to the demands of the operatives.

Dealing with the situation, *The Textile Mercury* for November 30 says that the ballots of the cotton operatives of spinning mills respecting their application for an increase of 40 per cent. on current rates of wages, show a decisive majority in favour of urging their claims. The application of the weavers for a 50 per cent. increase on current rates is also still unsettled, although some advance appears to have been made in the negotiations at conferences held during the preceding week.

In the North-East Coast district a 36-hour or 40-hour week is being demanded by certain of the engineering and shipbuilding workmen. One of the reasons put forward for the reduction is to make the work go farther with a view to reducing unemployment. It is very curious how persistent the fallacy seems to be, that the higher the labour cost of work can be made the greater will be the demand for workers. Another claim made is for a fortnight's holiday at full pay for all manual workers at the declaration of peace.

During the present coal shortage in Great Britain brought about by the war, the statement has been frequently made by trade unionists, says the *London and China Telegraph*, that only their own skilled miners can get coal. In this connection it is perhaps pertinent to instance the case of the Tongshan mines, now producing over 4,000 tons daily with Chinese coolie labour. Our contemporary believes that none of it is really highly skilled, and moreover it is frequently being changed. Our trade unionist friends may perhaps find this a hard nut to crack, adds the same journal; but it is not the only claim they have put forward which cannot be substantiated.

WOMEN ENGINEERS.

We have recently had many inquiries from women desirous of obtaining employment in engineering works after the war. It was not repetition work, like shell-making, that they were seeking, but rather designing, calculating and the like. The last four years have shown that a certain proportion of women have the instincts of the mechanical engineer and can undertake a large proportion of the duties that are found in engineering shops. So far they have had little scope beyond occasional tool setting, and making tracings. Women suffer from two disabilities in seeking to become engineers; they lack both workshop experience and technical training, and until facilities are afforded them in these respects they will find it difficult to make much progress. The war, however, has afforded thousands of women the chance of acquiring a knowledge of machine work on a limited scale, and some of them have made most excellent use of their opportunities. It has, however, done little or nothing to enable them to acquire a theoretical knowledge of engineering science, and without this there is little prospect of advancement for them. There is no reason why the latter state of affairs should continue. At Cambridge women and men are equally eligible for instruction in all subjects, and there have been several women students in the engineering laboratory, including Miss Rachel Parsons, the daughter of the Hon. Sir Charles Parsons. As far as we know there is no rule prohibiting women entering the engineering classes in most technical colleges, but so far there has been no welcome extended to them, and it will need much agitation and diplomacy to secure it. The National Council of Women of Great Britain and Ireland has now taken the matter up, and has published the following circular, showing the steps they propose to take to further the aspirations of women who desire to engage in engineering work.

The National Council of Women, realising that the work of reconstruction as it affects the women engaged in engineering and allied trades is of supreme importance, has appointed a Special Engineering Committee. These women have contributed largely by their steadfast work during the last few years of danger to the great victory we have now achieved, and this committee will give special attention to the future of women who have attained some degree of skill in these trades and professions and who wish to continue their work. Mr. Kellaway drew attention recently in the House of Commons to the great demand there will be for peace work. Thus in this time of reconstruction it is necessary that these trained technical women should have some central organisation so that their interests may be fully considered and their views may be expressed.

The organisation of the National Council of Women, with its numbers of branches all over the country, affords a ready means of reaching and keeping in touch with technical women.

The Engineering Committee by the words "technical women" means:—

1. Women with technical or mechanical training in engineering and allied industries.

2. Women responsible for the organisation of women's work in the shops and exclusive of women engaged principally on welfare work.

The aims of the committee are as follow:—

1. "To work for the admission of women into all suitable Institutes of Engineers, Iron and Steel, Metals, Gas and Illuminating Institutes, Naval Architects, and on to the Boards of the Universities and Technical Colleges of University rank, to the Technical Branches of the higher Civil Service, such as H.M. Patent Office, Technical Inspectors on the Board of Education."

2. "To secure opportunities for women equally with men to all technical schools and classes, colleges and universities."

3. "To secure the co-operation of all women doing technical work in Government factories, controlled factories and private firms with a view to utilising their skill in all reconstruction work in the immediate future."

In order that all technical women throughout Great Britain and Ireland who are working in engineering and allied trades should be able to take part in the important and urgent work of the Engineering Section, the committee invite all branches of the National Council of Women who are situated near any centres of the engineering industries, to form an Engineering Sub-Committee, who would be the nucleus of a large women's engineering alliance in their district.

These local committees in industrial centres would discuss the practical problems of the locality, collect information, initiate active propaganda among the technical women whom it is desired to co-ordinate, and facilitate organised inquiry from firms requiring technical assistants.

Engineering Committee.—Convener: Mrs. Ogilvie Gordon, D.Sc., Ph.D., F.L.S., 1, Rubislaw-terrace, Aberdeen. Hon. Secretary: Miss Rachel Parsons, 1, Upper Brook-street, London, W. 1. All communications to be addressed to the hon. secretary.

ROADS, THEIR SURFACES, CONSTRUCTION AND MAINTENANCE.*

By Ernest Leonard Leeming, M.Sc. Tech., Assoc.M.Inst.C.E.

(1) Road Corrugation.

The introduction of mechanically-propelled vehicles on highways has produced a troublesome and perplexing feature of road wear, namely, corrugation, which, owing to the existing war conditions, when the main roads of this country are heavily trafficked and their maintenance much neglected, has become serious.

The object of this paper is to state the present position of the problem with regard to road construction and vehicle design, and to indicate probable causes of the trouble, with some suggestions for preventing or alleviating it.

The phenomenon of wave formation or corrugation is met with in most cases of rolling motion on a plane surface. As a general rule, the formation of waves on a road surface is accompanied by longitudinal movement of the road material in the direction of the traffic, and this movement usually depends on the tractive resistance of the particular material; consequently, water-bound macadam is more likely to become wavy than tar macadam, and so on.

Horse traffic alone may cause waves to develop, but the damage to a road in this respect is only slight compared with that done by motor traffic. The action of the driving wheels of motor traffic is similar to the pulling action of horses' hoofs, and causes the upper layers of the road material to be moved backwards, *i.e.*, in the opposite direction to the traffic; sets, for instance, are tilted backwards. And therefore the combined effect of forward movement as a whole and tilting or backward movement of the surface is to produce ridges and hollows.

The effect of a wheel passing over the hollows of a corrugated surface, or over potholes, is to produce a blow on the opposite side of the hollow, and this is shown to depend upon $\frac{W v^2 l^2}{r^2}$ where W, v, l and r are unsprung weight, speed, width of hollow, and radius of wheel.

It is generally admitted that the road roller will form initial waves unless great care is exercised, and that traffic will quickly accentuate them. The Crompton three-axle roller introduces a principle which is of great importance in considering the road wave problem.

The action of a two-axle motor vehicle may be studied by observing the effect when the front wheels meet with an increased resistance due to a ridge or a pothole. The lead of the body of the vehicle on the front axle is increased and the lead of the back axle on the body is likewise increased, owing to the greater resistance to the driving effort; in other words, vibration of the vehicle as a whole is set up by the distance between the front and back axles changing with a definite period, according to the type and suspension of the vehicle. The wheel base appears to have some definite relation to the period of the waves formed, and a long wheel base assists the springing of the vehicle, and enables it to hold the road at speed when the surface is rough or wavy.

Considerable improvements in the suspension of the heavier motor vehicles are needed, the present practice only allowing of the absorption of shocks vertically, and not in the direction of the reaction of the blow on the road; in this respect, auxiliary springs, check springs and shock-absorbers are very useful.

The effect of the differential gear in continuing waves along and across a road cannot be too strongly urged, and it is this feature of motor omnibuses which probably accounts for the rapidity with which they propagate waves. If one wheel leaves the road surface, racing takes place, and impulsive driving in both wheels is set up; when the wheel returns to the surface of the road it produces a strong grinding effect on the material. The same action takes place when braking the rear wheels, except that the grinding action is in the direction of motion of the vehicle.

An interesting feature of road corrugation is, that it often commences earlier on down gradients and at bends than on straight level lengths of road. In the case of the down gradient, the reasons for rapid wave development may be stated as follows:—

(*a*) It induces increased speed and vibration.

(*b*) It increases the unsprung weight.

(*c*) Driving action and braking action are greater than on road levels.

(*d*) The road material is subjected to very great pushing stresses in a downhill direction.

The increased wear at bends is due mainly to the action of centrifugal force bringing greater weight on the outer wheels, and to the differential gear assisting racing and grinding action. The camber of a road, also, has some influence on wave formation.

The pitch of the waves is not easily determined from vehicle dimensions, since it often varies at different points on the same road under similar conditions of traffic. The occurrence of rudimentary waves, together with fully-developed waves, is another interesting feature of road corrugation. Generally, the pitch is less when the speed is greater; it is also quite independent of the kind of road material laid down.

With regard to the different classes of roads laid at the present time, set-paved roads are only capable of offering resistance to wave formation when laid on a concrete foundation. Where sets are laid on a yielding and inelastic foundation, corrugation will be quickly set up and considerable tilting and lateral movement will result from heavy traffic. Moreover, Durax paving and wood blocks do not seem able to resist the destructive forces of modern traffic, and sooner or later waves develop.

It is suggested in this paper that, wherever possible, sets or blocks should be laid arch-shape, in plan, to oppose the movement caused by traffic in a particular direction, so that the paving may be rendered unyielding both vertically and horizontally.

In the case of macadam and tar macadam roads the former is quite useless where heavy traffic is concerned, and even tar macadam offers no real solution to the problem.

The bituminous road surface appears to be the most suitable for modern traffic, on account of its great strength and also its elastic qualities, which go far to compensate for the unsprung weight of vehicles. Further, traction and vibration are reduced to a minimum. The development of waves on a bituminous surface is analogous to the formation of waves in the rolling of hot armour-plate.

It is possible that concrete as a surface, under good conditions, might prove a suitable material, but it has not been sufficiently tried in this country to enable definite conclusions of its wave-resisting qualities to be formed.

The conclusions of the paper show that unless two-axle vehicles can be provided with reasonably good springing, such as results from the air cushion of the pneumatic tyre, some development in the direction of providing three axles and increasing the number of driving wheels accordingly, for heavy vehicles, is necessary to alleviate the trouble of road waves.

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(2) Investigations in the Structure of Road Surfaces.

By Francis Wood, M.Inst.C.E.

Prior to the war, the question of the structure of roads was being brought into prominence through the advent of mechanically-propelled vehicles; there can be little doubt, however, that the transport needs of war have brought about a climax and emphasised the imperative and urgent need of providing roads with a structure that will (1) ensure a good and even surface, (2) be suited to the traffic, (3) be reasonable in first cost, and (4) be easily and cheaply maintained.

Considerable expenditure has been incurred in the past in providing elaborate foundations, which were in many cases necessary owing to the indifferent character of the surface, but there are many cases in which the strength and cost of this section of the road structures are such as would not have been necessary if the surface had been kept even and regular.

The author suggests that, provided a homogeneous mass of material is interposed between a stable substructure and the wearing surface (also homogeneous), the foundations need not be, in effect, more than 4 in. in depth, and such a combination will satisfy all traffic which reasonably conforms to the regulations that apply to vehicles in this country. It is common knowledge that no failure of the foundation of newly-laid wood pavements is noticeable until the surface begins to develop hollows through wear; it is then that the foundation of concrete begins to show defects.

An apparatus was designed and attached to the rear part of a motor car which would trace on a moving piece of paper the action of the wheel and the body of the vehicle as it passed a hollow in the pavement 18 in. long and 1⅜ in. deep at a speed of 5 miles to 7 miles per hour. From the resulting diagram various deductions are made, but the most important is that the vehicle was actually stopped in its progress, thus indicating that the momentum acquired by the load on the wheel had been expended on the side of the hollow. It is evident that a continued series of similar blows would

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* Abstracts of three papers read before the Institution of Civil Engineers, on Tuesday, December 3.

cause a very severe strain to the strongest foundation, and would be proportionately greater from commercial vehicles.

The test over an obstruction of the same height did not stop the progress of the vehicle.

The test emphasises the importance of "stitch in time" repairs, and also the provision of a wearing surface that will resist the wear to the greatest extent, so that hollows do not quickly develop through wear. Probably the bituminous type of pavement satisfies this demand better than any other that is known at the present time.

The paper deals with the two-coat mechanically-mixed or artificial asphalt type, as the cost of this construction is less than of natural asphalt. For average traffic it consists of a wearing surface about 1 in. to 1¼ in. deep laid on a 3-in. to 4-in. bituminous base coat.

Experiments proved that the base coat itself could be made to act not only as a base, but also to give the wearing surface, and would wear more economically than water-bound macadam. Disintegration began in the third year; the coat subsequently recovered, but disintegration again developed later, and eventually it failed under heavy traffic after about six years. The causes are investigated, and the failure is attributed to the expansion and contraction of the bitumen in combination with the use of large-sized stones.

The conclusion arrived at is that the surfacing material, which is exposed to considerable variations of temperature, should not have any particles larger than about ¼ in. when used with bitumen.

This points to a justification of the separate wearing surface coat laid on a base which can be made with a composition of large, medium and small-sized stone mixed with a suitably prepared tar.

In regard to the wearing surface coat many different compositions have been laid, and there has been a noticeable proportion of comparative failures. There has been a tendency to attribute these wholly to the bitumen used in the composition. In the author's view, although the bitumen plays a very important part, it is almost of minor importance compared with the grading of the mineral matter and the distribution of the bitumen.

Calculations are given which consistently indicate that the thickness of the film of bitumen on the surface of the particles of natural and artificial asphalt is such that Nature employs 50 per cent. less than is used in the synthetic asphalt. A table is given indicating the amount of bitumen required to cover any particular grade of material. From this table the percentage of bitumen required to coat any specified mixture of grades of material can be readily determined. The table will be advantageous in helping to ascertain whether the cause of the failure may be attributed to the lack of bitumen.

In the above comparison of natural and artificial asphalt, the percentage of bitumen by weight analysis is very similar to that of the artificial material. There would be a different result if volumetric analysis had been made. An example is given of two analyses of the same grading of bitumen contents, yet when the specific gravities had been determined, one shows 25 per cent. bitumen less than the other. Hence misleading conclusions may be arrived at unless the whole of the factors are taken into consideration.

In connection with the design of the structure, it must not be assumed that any grading of material can be used, or similarly that the grading should be so arranged as to give a voidless structure. A voidless structure *per se* will not necessarily give a good road structure; in fact a designed voidless structure will give a percentage of voids when in the road, because it is laid when the bitumen is in an expanded state, and as soon as it is cold it contracts and must leave voids. A rolled and tamped surface coating will show about 15 per cent. to 20 per cent. voids on the underside of the coat, while at the surface it is free from voids.

Examples are given of aggregates of various sizes to bring about a near approximation to a voidless composition, the amount of bitumen that would be necessary to fill the void is calculated, and it is shown that it would not properly coat the surfaces.

Pavements that have proved satisfactory show that the fine particles must predominate. It is probably the case that the bitumen containing what are technically termed colloids (*i.e.*, impalpable material of such fineness that if mixed with water it will not settle out after 20 minutes' quiescence) will be more successful than the bitumen that contains no colloids or their equivalent. Apart from this, the opinion is expressed that in the bituminous wearing surface coat about 40 per cent. of the aggregate should be of 200, 100 and 80 mesh (the larger proportion being 200 mesh), 40 per cent. of 50, 40 and 30 mesh, and 20 per cent. of 10 to ¼ in., and that the film thickness on the surface of the particles should be at least 0·00065 in. to 0·00070 in.

The author further indicates that there is no advantage in any particular material that is used as the aggregate, that almost any that is locally obtainable, provided it is in a free state and of suitable grading, may give equal results; *e.g.*, clinker from a refuse destructor ground to the necessary sizes, grit swept from macadam roads, wood fibre, &c.

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(3) NOTES ON ROAD CONSTRUCTION AND MAINTENANCE.

By THOMAS BOWYER BOWER, Assoc.M.Inst.C.E.

Roads are one of the most important of an army's needs. The improvement of the roads of the United Kingdom is a subject of increasing importance, and experience shows that the possibility of military considerations becoming involved should not be neglected in their design and construction.

The average English roads and by-roads are, as a rule, well made, but to carry military traffic they should be not less than 24 ft., and, if possible, 30 ft. wide.

The roads of France, chiefly constructed under Government supervision, were excellent for the traffic likely to use them.

For civilian traffic in peace time, consisting chiefly of slow carts and light motor cars, they are no doubt adequate, but both construction and material—largely a friable limestone—have proved unsuitable for heavy and fast military traffic. The original good condition of the roads, with favourable weather, delayed the appreciation of this, but after the second winter of hostilities, the road surfaces having become bad, frost got into the foundations, and with further increase of traffic the roads got into a deplorable condition. Material was scarce, and temporary measures had to be adopted.

The commonly accepted view that the excessive amount of mud on the roads of France is due to the metal being forced down to the chalk or other subsoil, which then comes to the surface as mud, is disputed by the author. Excepting the case of *pavé* roads, and roads badly worn in holes, he is of opinion that no mud rises to the surface by pressure from above. The true cause of mud formation is the poor quality of the material used, viz., limestone of very soft and porous nature, which, by attrition through some inches of depth, forms the mud, while destroying the surface. The only other materials available in France were pit-props, whole or split, brick rubble, and a poor quality of flint gravel.

The author then describes methods of repairing holes, deep holes being dealt with by "pigstying" with pit-props, filled in with earth and covered with a foundation of soling rock and a coat of macadam.

The author has reached the conclusion that there is but one way, as now given, of constructing a road fit to stand abnormal traffic for long. Drainage must first be dealt with. No ditch should be nearer the road than 6 ft., the bottom being 1 ft. below road formation. Side drains from road edge to the ditch should be not more than 50 ft. apart. If the road on one side cuts into a hill slope, culverts must be formed under the road leading from one ditch to the other—these, whether of stone slabs or wood, should not be less than 18 in. square. Side-tilted roads draining across the surface are to be avoided. The edge of the road next the falling ground, if wanting from any cause the 6 ft. margin between the road and the ditch, must be securely supported to take the pressure induced by road traffic, which has a tendency to push the edge of the road outwards, causing the road to lose its camber. A method of securing road edges is then described.

Road excavation must be taken out across the whole width to 18 in. below the finished road surface, the bottom being curved to conform to the road camber, which may vary between 1 to 12 and 1 to 50, 1 to 25 being a fair average.

It is well to have upon the ground soling rock, seconds and macadam, in advance of excavation, to avoid delays which may expose the foundation to weather influences. Excavation being completed, the bottom is covered with a 2-in. layer of ashes, or clinker; this, though not essential, is desirable. The soling rock is then packed and rolled as already described for mending holes. Where the soling rock, when set and keyed, is rough it will be well to hand-pack the rock seconds that come next, if only for one stone thick, "throwing in" to make up the desired thickness; 9 in. to 12 in. of soling rock is sufficient. If this is not procurable hard block chalk will serve, though not so good. The "seconds" should be from 4 in. to 6 in. thick, as also the macadam finish. Each layer should be rolled as completed.

This makes a good road easily maintained, and serviceable even when the macadam is worn away.

Corduroy roads are possible only in a well-wooded country, and last but a short time unless well covered with metalling, without which the foundation soon becomes wet and soft, with consequent disturbance of the timbers.

To construct a good corduroy road attention must first be given to drainage and excavation carried out as for metalled roads, when "beds" to receive the longitudinal stringers should be excavated, one on each road edge and one at the centre, with two intermediate channels, the centre channel being of width sufficient to take two timbers spaced 2 in. or 3 in. apart.

When laid the corduroy must be secured by ¼ in. diameter wire fastened by staples to each timber. At every 15 ft. it is desirable to drive pickets, to secure the timbers from shifting. On completion the corduroy should promptly be covered with a thin layer of ashes, or dry soil, followed by a layer of seconds and macadam well rolled in.

Some principal faults in road construction are: Delay in drainage arrangements until late in the work; careless laying of soling rock on irregularly formed bottom. Packing soling rock on edge with length of stones transverse to road, in which case the stones are liable to tilt forward in the direction of traffic with consequent disturbance of road surface.

THE SOCIALISATION OF THE GERMAN INDUSTRY.—The socialisation of certain German industries, notably the mining, the iron and steel and the textile industries for which the extreme wing clamours, is not likely to materialise at the present moment. The Government does not find the time expedient and fears that the German industry cannot stand any further disturbance at present, lest its foundation should be entirely shaken. The Bavarian shares the view of the Berlin Government, and deems it inopportune to transfer industries to the State at a time when it is entirely exhausted. In the meantime industrial circles are alarmed at the prospects of immediate higher taxation.

"COAL SAVING BY SCIENTIFIC CONTROL OF STEAM BOILER PLANT."

TO THE EDITOR OF ENGINEERING.

SIR,—I regret I have been unable to thank Mr. Casmey before now for his closer analysis of my letters regarding stokers. Apart from this correspondence, we all know Mr. Casmey's enthusiasm on this subject. Personally I am but one of the many who are giving a lot of their time to improve this matter, and I find it a great pleasure to have the humble appreciation of even a stoker.

Now then, regarding the Lancashire boiler. Mr. Casmey can get better results from the Yorkshire boiler, with a reduction of material used in construction, due to length principally, but also to method of flue design, which I agree is better than the "Lancashire."

He applies this system to the Lancashire—not by altering the diameter of the flues at the back ends, but by reducing the firegrate area at the front end, so as to bring his ratio more into line.

Assuming his method to be correct, I suggest that the same idea could be applied to increase the efficiency of the Lancashire evaporative capacity, by increasing the diameter of the flues at the back. Here constructive difficulties arise, expansions of brickwork are more, leaks through imperfect work in bricks still take place and gradually get worse as the time goes along. Long horizontal flues hold fine residues of ash, &c., and numerous other things could be mentioned if necessary, all of which can be greatly reduced in effect by the application of water-tube boilers. In these the gas exit can be made to any size, fuel combustion can be kept right both visually and mechanically. The thickness of metal for high-pressure work is not beyond the limits of safety and economical heat transmission, not forgetting the effect of expansions, which can be neutralised much better in a high-pressure water-tube boiler, than in a Lancashire boiler.

Incidentally the article on "Power Station Problems," in this week's ENGINEERING is a coincidence, and may be taken generally as further convincing proofs of several advantages of the use of water tube boilers.

Now that the war is practically over, so far as fighting is concerned, I suggest that we turn our minds towards something better than temporary benefits so far as use of coal is concerned, and I am glad to note also in this week's issue of your paper, under your illustrated patent record, that Messrs. Mertz and McLellan have been busy in this respect.

The letter of C. F. Wade contains many true facts, but he, like many others, cannot recognise the losses away from the boiler-house. I should have thought the instance in saving shown a week or so ago would have been sufficiently glaring.

Yours faithfully,

JOHN H. ANDERSON.

Purfleet, Essex, December 1, 1918.

"STUDENTS FOR DEGREE COURSES."

TO THE EDITOR OF ENGINEERING.

SIR,—Allow me to add my support to Mr. Wollaston's proposal, published on page 611 of your last issue, to allow students who give evidence of the requisite education, to take their degree through the medium of night classes or part-day courses.

There are large numbers of youths who joined the Army in 1914 at the ages of 18 to 20 and are now 23 to 25 years of age. Many had passed their matriculation and further studied at night classes or day apprentice courses in engineering. Where such persons can show that they possess the necessary knowledge, the least the universities can do is to allow them to take the honours degree after two years at the university or, say, three years at night classes.

Yours, &c.,

JOSEPH BUTTERWORTH.
(President Manchester Association of Engineers.)

Albert-square, Manchester, December 2, 1918.

REINFORCED CONCRETE SHIPS.

TO THE EDITOR OF ENGINEERING.

SIR,—I enclose an extract from a paper published sixty-four years ago which refers to the use of iron wire and cement for building ships. From this it would seem that the attempt to build ships of this muddy mixture is not altogether new.

Yours truly,

H. R. CULLEN.

The Marine School of South Shields,
December 2, 1918.

From *The London Journal* for the week ending December 23, 1854:—

Novelty in Shipbuilding.—M. Lombo-Miraval has called the attention of the Société d'Encouragement to a method of constructing ships, perfectly novel. According to this system, vessels are made altogether of iron wire and hydraulic cement, and the inventor attributes to them the following advantages. Great solidity, absolute impermeability, facility of repair in case of shipwreck, perfect stability, by the ballast being fixed to the bottom and forming part of the frame, and, finally, incomparable rapidity of construction. A barque, constructed six years ago upon this system, has been since navigated without requiring any repairs, although it has undergone some rough tests. "Nothing would be easier," says M. Miraval, "than to construct, in a few days, on board the vessels of an expeditionary fleet, as many gun-boats or debarkation rafts as may be desirable."

FLOATING ELECTRIC POWER STATION.

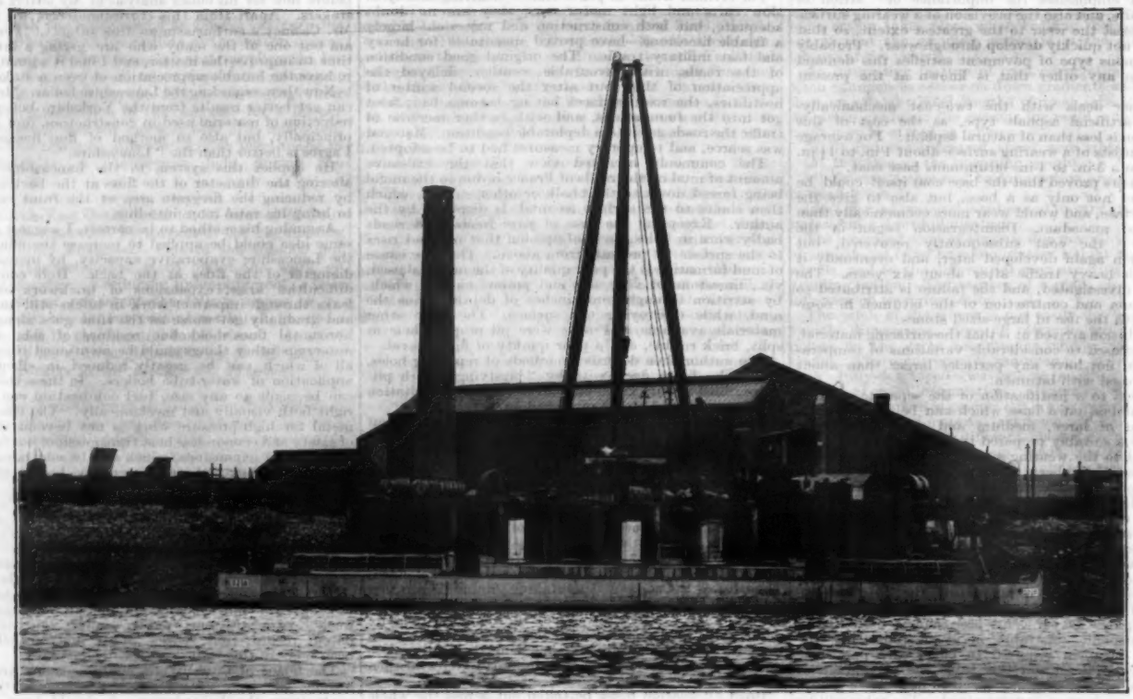


Fig. 1.

It is a truism that the war is a contest of mechanisms, and there is scarcely a branch of engineering that has not been called upon to give its assistance in the formation of the complicated and successful fighting machine. Amongst the many problems calling for solution has been the question of electric power supply to meet very variable conditions overseas, and we are now able to publish particulars of a plant giving the necessary mobility and convenience which was designed under the direction and for the service of the Directorate of Inland Waterways and Docks, War Office. It takes the form of a floating electric power station, and the nature of the duty calls for such a wide range of supply that the equipment has many interesting features. Direct-current supply can be given between 110 volts and 575 volts, and alternating current from 220 volts to 7,600 volts. A general view of one of the stations during fitting-out is given in Fig. 1, and this picture has an historical interest in the fact that the Turbinia, the first sea-going turbine-driven ship, is partly visible to the left of the workshops.

The plant is installed on a large steel barge, and the accommodation consists of two dynamo rooms, placed fore and aft, and a boiler-room amidships (Figs. 2, 3, and 4, page 645). As the boilers are oil-fired, it has been possible to make the installation exceedingly compact, and to reduce to a minimum the personnel required for operation. The nominal capacity is 1,000 kw., but owing to the elasticity obtainable with liquid fuel and the generous design of the machines, a considerably larger output may be obtained at short notice for peak loads.

Boilers.—The steam-raising equipment consists of six single-ended single-furnace boilers of marine type, of 800 sq. ft. total heating surface. They have each an equivalent evaporation of 5,500 lbs. per hour, the working pressure being 200 lbs. per square inch. Under these conditions and with feed water at a temperature of 150 deg. F. the rate of evaporation is about 13 lbs. of water per pound of oil having a higher calorific value of 19,000 British thermal units per pound. The oil-burning system is of the low-pressure type—*i.e.*, for a working oil pressure of 60 to 70 lbs. per square inch. There is one burner per boiler and these are fed from the oil pumps through a ring main system, so that there are two fuel routes to each burner. The oil-fuel pumps and hot and cold filters are in duplicate, and the working pressure is adjustable by means of a spring-loaded valve which by-passes to the pump suction. There are two oil tanks, each having a capacity of about 20 tons, and these are replenished by a re-fuelling pump, thus making the station independent of the type of craft furnishing the supply.

Air-supply to the furnaces is maintained by steam-driven, or alternatively, motor-driven fans, the motors being 440-volt squirrel-cage machines. The steam fans are used for light load conditions or when there is no alternating-current load being supplied. The dynamo rooms and boiler room are so arranged that the air is drawn through the former, thus helping to keep them cool. This is particularly necessary in the aft dynamo room, as two of the boilers face this room in order to economise space. The make-up feed water is provided by a marine type evaporator operating with exhaust steam, which discharges to the hot well. On the way to the boilers the water passes through a filter placed on the suction side of the feed pumps, which are of the vertical direct-acting type.

There are two generating sets in each station, each set consisting of turbine, speed-reduction gear, alternator, exciter, and direct-current generator, these five units being mounted on a sectional cast-iron bed-plate and connected by two flexible couplings, Fig. 5, on page 648, shows the set in the aft dynamo room.

Turbines.—The turbines are of the impulse-reaction type of 500 kw., economical rating taking saturated steam at 200 lb. per square inch above atmosphere, and exhausting at an absolute pressure of 1½ lb. per square inch. The speed is 5,000 r.p.m., and is reduced to 750 r.p.m. by the reduction gear. The governing gear includes a trip device to operate the emergency valve in the event of failure of the lubricating oil pressure. The greater part of the reaction portion of each turbine is fitted with what is usually termed "end tightening" blading, *i.e.*, having axial clearance, the last few rows having the usual tip clearance. The end thrust is taken up entirely by a Mitchell thrust block which is arranged so that the axial clearance of the fixed and moving blades can be increased when starting up. The exhaust steam is taken into a surface condenser of 785 sq. ft. cooling surface, served by a steam-driven centrifugal pump for circulating water and a marine type air pump which discharges to the hot-well.

Auxiliaries.—All the auxiliaries, except the motor-driven fans, are steam-driven, and the exhaust steam is collected and utilised for feed-water and oil-heating. The arrangement consists of an exhaust main collecting from the engine driving the circulating pumps, fans, air pumps, &c., and distributing to the tubular feed-water heater and evaporator. A branch to the oil tanks also serves the heating coils there to reduce the viscosity of the oil when necessary. These arrangements ensure the maximum use being made of the steam supplied to the auxiliaries, so helping to maintain the overall efficiency of the plant.

Generators.—Each alternator has a continuous rating of 625 k.v.a., the normal voltage being 440. They are eight-pole, forced ventilated machines, with rotor fans drawing the air in axially and discharging through a vertical duct above deck level. The field system is of the salient-pole type, poles and rotor centre being in one piece and of cast steel. The field windings are of strip on edge, and heavy damping coils are fitted to the laminated pole tips. The exciters are low voltage machines, 38 volts, and they supply also the field current of the direct-current generators.

The direct-current generator consists virtually of two machines with armatures back to back, capable of a combined output of 500 amperes at 220 volts to 575 volts, *i.e.*, 110 volts to 287 volts per armature; the intention being that either a three-wire system or a 500-volt traction circuit may be supplied. With an alteration to the connections of the field coils, the machines may be run self-exciting instead of from the exciter. Over-compounding up to 15 per cent. at full load can be obtained, and a diverter switch on the generator frame enables this to be adjusted in four steps from plain shunt. All these machines can safely deal with an overload of 50 per cent. for 2 hours, and parallel running is also arranged for between the two engine rooms on both the alternating current and direct-current supplies.

Transformers.—To supply high-tension systems there is a 500-k.v.a. three-phase transformer provided for each alternator. These transformers are oil-cooled with radiating tubes and fitted with an expansion chamber. The ratio is 440/1,936 per limb, but the windings can be connected in various ways, which, combined with alternator regulation of 400 volts to 600 volts by rheostats, enable practically any transformer terminal voltage between 1,760 and 7,600 to be obtained. The secondary windings are in two separate sections and the various arrangements possible give six different ratios, with all of which the transformers can be operated at full load. Two further ratios can be obtained, making eight in all, by star-connecting the primary windings; these, however, do not allow the transformer to be operated at full load except for short periods.

Switchboards.—The switchboards are of a skeleton design as seen in Fig. 6, page 648, with the usual control

FLOATING ELECTRIC POWER STATION.

Fig. 2. LONGITUDINAL ELEVATION

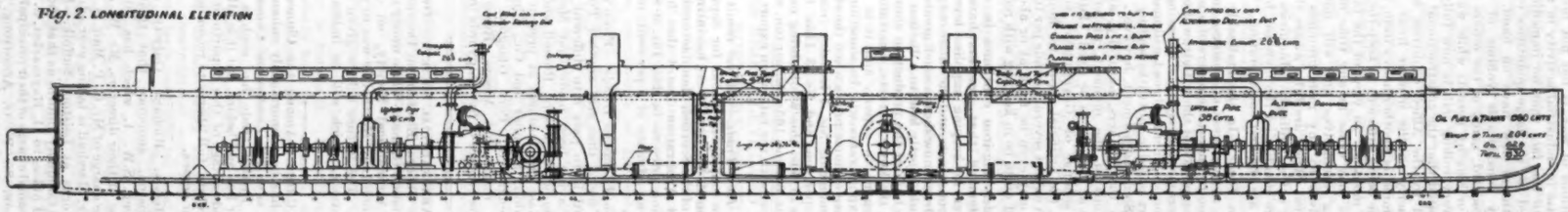


Fig. 3. DECK PLAN

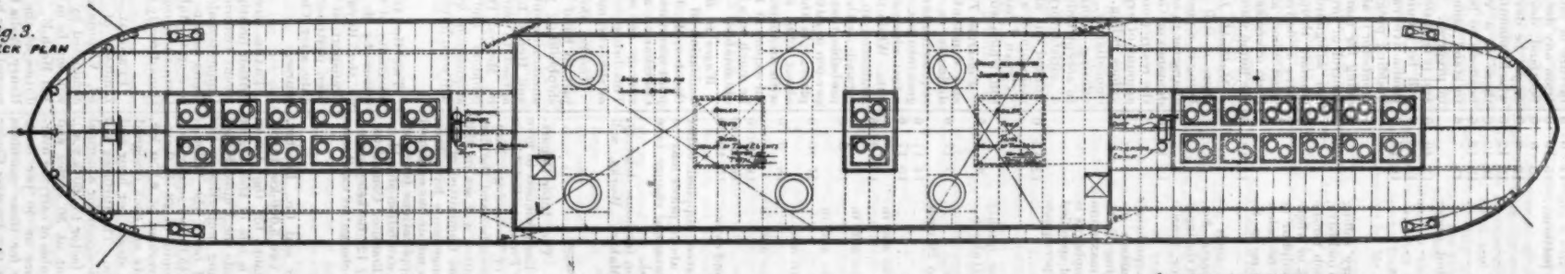
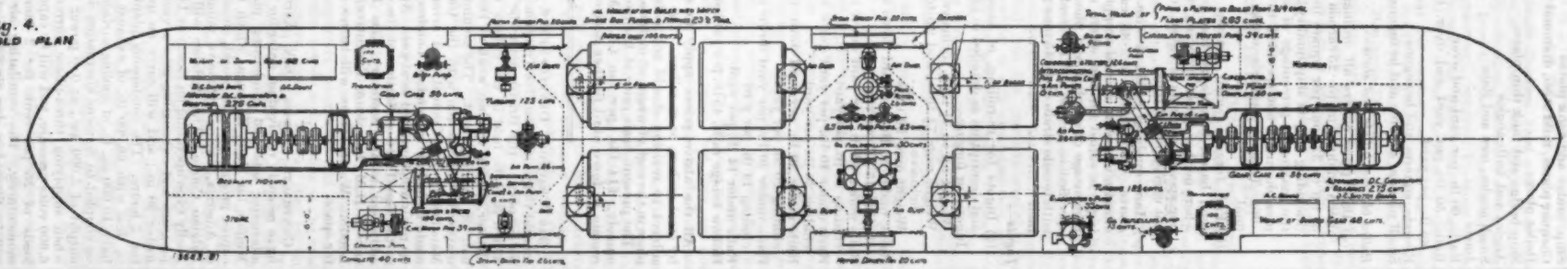


Fig. 4. HOLD PLAN



gear and protective features. Provision is made for supplying direct-current lighting, power and traction, and as already mentioned, this can be done within a range of 110 volts to 575 volts, a changeover switch on the generator panel connecting to the alternative feeder circuits. The control of alternating current is done by three panels with oil switches, &c., one of these panels giving a supply to the transformer which is placed adjacent to the switchboard. There is no high-tension switchgear on board. Cab-tyre sheathed cable has been used extensively for machine and other short leads, and paper-insulated lead-covered cable for interconnections between the two dynamo rooms.

In spite of the limited space, room has been found for a well-appointed workshop equipped with lathe and drilling machine, &c., the tools being driven from a line shaft by a 3-h.p. squirrel-cage motor. There are also store room and office, with a ship telephone installation between the dynamo rooms. The plant was designed by Messrs. Merz and McLellan, of Newcastle-on-Tyne, under the supervision of the Inland Waterways and Docks Department, Messrs. C. A. Parsons and Co., Ltd., being the contractors for the machinery.

REMOVAL OF CERTAIN RESTRICTIONS ON NON-FERROUS METALS.—The Ministry of Munitions in the disposal and allocation of stocks of non-ferrous metals in their possession to consumers, will be prepared to pay brokers and recognised intermediaries a commission of ½ per cent. subject to cash payment for the material.

THE CAMMELL LAIRD-FULLAGER HEAVY OIL ENGINE.—Under the above title, Messrs. Cammell Laird and Co., Limited, are now making an internal-combustion marine engine of the two-cycle type with opposed pistons. By this arrangement perfect balance is obtained and the bearing reactions are 50 per cent. less than customary. It is stated that the test results show that 50 per cent. more power can be developed in a given space than is practicable with the usual type of engine. An advantage claimed is that propeller speeds are lower than is usual in ships fitted with internal-combustion engines.

THE MINERAL RESOURCES OF THE UNITED KINGDOM.—There has just appeared the report of the Controller of the Department for the Development of Mineral Resources in the United Kingdom. It is to be obtained from H.M. Stationery Office at Imperial House, Kingsway, London, W.C. 2, at the price of 6d. (Cd. 9184). The publication begins with a report by Sir Lionel Phillips, Bart., which "must be regarded as a statement of his personal views." This recounts what the department has done to assist in the exploitation of mineral resources in this country, and makes many suggestions as to the action of the Government in the future. Then follows the main report. This deals with aims of the department, general outlook, labour, production, coal and iron, tin, lead, zinc, oil shale, arsenic and arsenical pyrites, copper ore and precipitates, iron pyrites, bauxite, antimony, manganese, wolfram and scheelite, cobalt, graphite, nickel, chromite, uranium ore, soapstone, natural gas, ochre, umber, diatomite barytes and witherite, salt, sandstone, gypsum, gravel and sand, slate, chalk, chert, flint, clay, igneous rocks, and sulphate of strontra. In all cases statistics of production and prices are given as far as possible, both for war time and before, and also particulars of the areas where the ores are found. Part II deals with the output of the country as a whole, and then with individual areas, discussing the prospects of the various industries, and the efforts that have been made during the war to develop them. The appendices contain lists of the mines that have been reported on by Government engineers, statistics of output of wolfram, arsenic, tin, miscellaneous ores and minerals, lead and zinc. The whole publication is a valuable compilation showing the present and future capacity of our mineral industry.

MOLYBDENUM.—Pure molybdenum, free of all oxide, can, according to Kuno Wolf (Dissertation, Aachen), be obtained from the commercial metal by heating it up to 2,250 deg. C. for 5 hours or 6 hours in a current of hydrogen; the metal can then be formed into sticks without application of pressure. The exclusion of oxygen is one of the chief difficulties in the preparation of the pure metal and its compounds. With chlorine molybdenum forms the black, deliquescent pentachloride $MoCl_5$; heated to 250 deg. C. in a hydrogen atmosphere, this pentachloride turns into the brownish-red amorphous trichloride $MoCl_3$, which, itself heated in CO_2, is converted into the volatile tetrachloride and the amorphous refractory pale-yellow dischloride $MoCl_2$. This dichloride must not be heated in air, however, in which it turns into a white woolly sublimate and black oxide. Analytically molybdenum can be determined as hydrated sesquioxide by electrolysis; but the yield is very poor, so that technically this electrolytic separation would not answer.

HOME AND EXPORT PRICES OF IRON AND STEEL.

The Ministry of Munitions has this week issued the following lists of prices.

The following fixed prices shall be charged for deliveries for export on and after November 18, 1918, until further notice, except for deliveries under contracts made prior to November 16, 1918, for which priority certificates and export licences have already been obtained. These prices are for delivery f.o.b. port of shipment for net cash against documents, and apply equally to makers, merchants and agents. Makers may, however, allow to merchants or agents a discount not exceeding 1½ per cent. A merchant or agent purchasing steel for export shall make a declaration in writing to the steel-makers to that effect in respect of each such purchase.

	List.	Fixed Basis Prices. per ton. £ s. d.
Ship, bridge and tank plates	A	16 10 0
Boiler plates	C	17 10 0
Chequer plates	J	18 0 0
Ship, bridge and tank thin plates ...	B	19 10 0
Angles and other sectional material ...	D	16 2 6
Small angles, tees and flats	E	20 0 0
Joists	H	16 2 6
Rounds, squares and hexagons ...	F	17 10 0
Small rounds, squares and hexagons	G	20 0 0
Rails, 60 lb. per yard and over		15 10 0
Rails under 60 lb. per yard down to and including 50 lb.		15 12 6
Rails under 50 lb. per yard down to and including 45 lb. per yard		16 10 0
Rails under 45 lb. per yard down to and including 40 lb. per yard		18 10 0
Rails under 40 lb. per yard down to and including 30 lb. per yard		19 0 0
Rails under 30 lb. per yard down to and including 20 lb. per yard		19 10 0
Rails under 20 lb. per yard down to and including 14 lb. per yard		20 0 0
Rails under 14 lb. per yard		20 10 0
Billets, per Schedule E, description (A) ...		13 10 0
Billets, per Schedule E, description (B) and (C)		15 0 0

Extras same as for home sales, see authorised list.

The above prices apply to steel supplied either by steel-makers or re-rollers.

Bar iron £20 0 0

A drawback is payable to the Government on exports of the above materials on account of subsidies.

Export Prices: Pig Iron.

The following fixed prices shall be charged for deliveries for export on and after November 18, 1918, until further notice, except for deliveries under contracts made prior to November 16, 1918, for which priority certificates and export licences have already been obtained. These prices are for delivery f.o.b. port of shipment for net cash against documents, and apply equally to makers merchants and agents. Makers may, however, allow to merchants or agents a discount not exceeding 1¼ per cent. A merchant or agent purchasing iron for export shall make a declaration in writing to the iron makers to that effect in respect of each such purchase.

	Per ton. £ s. d.
Hematite pig iron—	
East Coast, mixed, Nos. 1, 2, and 3 ...	8 12 6
Scottish, mixed, Nos. 1, 2 and 3	8 12 6
Welsh, mixed, Nos. 1, 2 and 3	8 12 6
West Coast, mixed, Nos. 1, 2 and 3 ...	8 17 6
Malleable hematite pig iron—	
Refined cupola cast	10 10 0
Cast direct from blast furnaces, large pig, all grades	9 7 6
Foundry and forge pig iron—	
Cleveland, No. 3 foundry	7 5 0
Cleveland, forge	7 5 0
Derbyshire, Leicestershire and Nottingham, No. 3 foundry	7 2 6
Derbyshire, Leicestershire and Nottingham, No. 4 forge	7 2 6
Lincolnshire, foundry	7 7 6
Lincolnshire, forge	7 7 6
Northamptonshire, No. 3 foundry	7 0 0
Northamptonshire, No. 4 forge	6 17 6
North Staffordshire, foundry	7 7 6
North Staffordshire, No. 4 forge	7 5 0
South Staffordshire, Shropshire and Worcestershire, part mine foundry	7 12 6
South Staffordshire, Shropshire and Worcestershire, part mine forge	7 10 0
Scottish, No. 3 foundry	8 4 0
Basic pig iron—	
Cleveland	7 10 0
Derbyshire, Leicestershire and Nottingham	7 7 6
Lincolnshire	7 7 6
Northamptonshire	7 7 6
North Staffordshire	7 7 6
South Staffordshire, Shropshire and Worcestershire	7 7 6

Subject to all usual variations for quality which have been sanctioned by the Ministry for the home trade.

A drawback is payable to the Government on exports of the above materials on account of subsidies.

List of Steel Prices to come into Operation for Home Deliveries on and after February 1, 1919.

	Per ton. £ s. d.
Ship, bridge and tank plates	14 0 0
Chequer plates, mild steel, diamond pattern...	15 10 0
Boiler plates	15 0 0
Ship bridge and tank thin plates	16 0 0
Angles and bulb angles	13 12 6
Small angles, tees and flats	16 10 0
Joists	13 12 6
Rails, 60 lb. per yard and over	13 7 6
Rails, 50 lb. per yard and over, but under 60 lb. per yard	13 10 0
Rounds, squares and hexagons	14 5 0
Small rounds, squares and hexagons ...	16 10 0
Rolled blooms, billets and slabs—	
(*a*) Base price covers all ordinary rolling down qualities up to ·25 carbon inclusive, or up to 32 tons per square inch tensile (including Lloyds ship quality), or where the maximum percentage of sulphur or phosphorus is not specified to be below ·06. Test at maker's works is to be final	11 12 6
(*b*) For forging small articles such as shell bases, baseplates, fuse parts, &c., where neither special cropping of the ingot nor special analysis is called for, tensile not exceeding 32 tons	12 15 0
(*c*) Hard qualities (such as wire qualities) above ·25 carbon to ·85 carbon inclusive, where no special cropping of the ingot is called for and where maximum percentage of sulphur and phosphorus is specified to be ·06 and for steel specified with tensile strain up to 45 tons per square inch	12 15 0
Ingots—	
(*g*) Ingots for re-rolling, of same quality and description as detailed in (*a*) above...	9 5 0
Ingots for forging—	
Weight up to 7½ tons, inclusive	13 17 6
Weight over 7½ tons, and up to 20 tons, inclusive	14 17 6
Weight over 20 tons	15 17 6
Rails, under 50 lb. per yard down to and including 45 lb. per yard	15 2 6
Rails under 45 lb. per yard down to and including 40 lb. per yard	17 0 0
Rails under 40 lb. per yard down to and including 30 lb. per yard	17 10 0
Rails under 30 lb. per yard down to and including 20 lb. per yard	18 0 0
Rails under 20 lb. per yard down to and including 14 lb. per y rd	18 10 0
Rails under 14 lb. per yard	19 0 0
Hollow bridge rails, 45 lb. per yard and over...	15 10 0

All the above prices apply to steel supplied either by steel makers or re-rollers. The above prices may be subject to revision should any substantial change take place in the cost of wages of material.

The present basis price of bar iron for home delivery, namely, £14 15*s.* per ton f.o.t. Makers' Works, will remain in force until further notice.

Gas Traction Developments.—The Inter-Departmental Committee on Gas Traction has promised to give its support to the British Scientific Products Exhibition which is to be held in the College of Technology, Manchester, during the last week of December and the first half of January next. The committee will act in this matter in conjunction with the Gas Committee of the Manchester City Council, and arrangements have been made to include a standard London motor-bus equipped to run on compressed coal-gas. Applications for space in the Gas Traction Section of the exhibition should be addressed to the Secretary, Gas Traction Committee, care of H.M. Petroleum Executive, 12, Berkeley-street, London, W. 1. There will be no charge to exhibitors for space.

Contracts.—Messrs. Dick, Kerr and Co., Limited, have recently received an order for two 5,000-kw. turbo-alternator sets and condensing plants for the Union Miniere du Haut Katanga, which is one of the largest copper producers in the world, outside the United States of America, having extensive mining properties in the Belgian Congo. The turbines will be of the Willans-Zoelly type operating on steam at 145 lb. per square inch pressure and exhausting into a vacuum of 28 in. (barometer 30 in.) and will carry an overload of 6,250 kw. for 2 hours. The condensing plants are each designed to deal with 66,000 lb. of exhaust steam per hour and have 10,000 sq. ft. of cooling surface. The turbines will be coupled to Siemens alternators designed for a normal output of 5,000 kw., at 0·9 power factor (5,560 k.v.a.), when supplying three-phase current at 50 cycles and 6,600 volts pressure, and will be capable of carrying overloads of 25 per cent. for 2 hours or 50 per cent. momentarily. The ventilating air for these machines will be filtered in dry air filters of the Premier Cooler Company's make; the machines will each be fitted with a direct-coupled 110-volt exciter of the overhung type and will operate in conjuncton with an automatic voltage regulator.—The Paterson Engineering Company, Limited, of India House, Kingsway, London, have received an order for supplying their rapid filtration plant to Bombay.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Scotch Steel Trade.—Although the cessation of hostilities has brought to an end the urgent necessity for the manufacture of munitions of war, it has not brought in its train any decrease in industrial activity in the West of Scotland, despite the fact that no immediate use can as yet be devised for the large quantities of shell steel which manufacturers now have on hand. Meantime there is a very considerable volume of commercial business to be tackled, many of the orders having had to stand aside for lengthy periods while war work was in progress. Every rolling mill is now fully employed and it is anticipated that the constructional work which will be required by the Allied countries will tax the productive capacity to the utmost limit. The ship-building programme is another heavy item, the requirements for it alone being sufficient to keep the steel works going for many months. In view of the fact that the control of prices may cease at any time now, makers are safeguarding themselves and will not wittingly commit themselves to any rash promises concerning rates or deliveries. They are fully aware that changes must come, and act accordingly. Inquiries and orders from overseas are steadily on the increase, but even yet the home wants are the first consideration.

Malleable Iron Trade.—In the malleable iron works there is still an active press of business, makers now being in a position to undertake orders of a more general character in consequence of the withdrawal of the heavy demands on Government account. The easing-off, too, of the restrictions on shipments abroad will make a certain amount of export possible, notwithstanding the inflated values ruling. Some adjustment, however, is expected immediately, so that makers, naturally, are chary of offering quotations at the moment, preferring rather to accept orders at "prices to be fixed" later. Should a satisfactory scheme of Government subsidies be worked out and the artificial rating for home trade be maintained, with export several pounds per ton in excess, "Crown" bars may even be fixed at or about 20*l.* per ton, which would quite be in keeping with recent figures.

Pig-Iron Trade.—Pig-iron continues in such heavy and constant demand that smelters have as much difficulty as ever in keeping supplies level with the requirements of consumers, and the entire output speedily goes into use. Orders now show a much greater diversity, a fact which should shortly lead to a distinct broadening out. While the bulk of the production continues to be swallowed up in the home markets, a certain stringency prevails with regard to export, and it is more than probable that export rates will be something like 50*s.* per ton in advance of home prices when the change takes place. At the moment, No. 1 foundry iron is quoted about 120*s.* 6*d.* per ton, and No. 3 115*s.* 6*d.*, so that with an increase of 50*s.* this would bring out the price for export at 170*s.* 6*d.* and 165*s.* 6*d.* per ton, which would be much on a level with the rate when export licence was obtainable.

Wages in the Iron Trade.—As the result of his examination of the employers' books for September and October, Mr. John M. MacLeod, C.A., has intimated to the joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board that he finds the average net selling price to be 15*l.* 16*s.* 9·8*d.* per ton. This brings out an advance of 5 per cent. in the wages of the workmen.

Another Shipyard Changes Hands.—From information just to hand it seems that still another Port Glasgow shipbuilding yard is to pass into different hands, the announcement having been made that Messrs. James and Henry Lithgow, of Messrs. Russell and Co., have agreed to purchase the business at present carried on by Messrs. Dunlop, Bremner and Co., Limited, ship-builders and engineers, Port Glasgow. This new acquisition will mean that Messrs. Russell and Co. will soon have the control of five shipyards in the burgh.

The Royal Aeronautical Society.—Owing to the proximity of the General Election on December 14, the lecture by Mr. Claude Graham-White under the auspices of the Royal Aeronautical Society, on Civil-Aerial Transport, at which Lord Northcliffe was to preside, has been postponed. The lecture will be given at an early date after Christmas, which will be indicated in due course.

Trade with China.—Among the Chinese at large British prestige has been enormously enhanced by the recent victories, says *The London and China Telegraph*. Unquestionably British trade has such a chance in China as it never has had before, but it is idle to expect to reap the full advantage of this opportunity so long as German houses retain full liberty to recommence operations directly war ceases.

Personal.—Messrs. Richard Garrett and Sons, Limited, of Leiston, announce that their office at 53, Victoria-street, S.W. 1, which has hitherto been conducted by one of their directors, Mr. W. J. Marshall, will now be in the charge of Mr. G. P. Mair, A.M.Inst.C.E. M.I.Mech.E. Mr. Marshall is taking over administrative duties at the works at Leiston, Suffolk.—Messrs. the Henry Wells Oil Company inform us that they have removed their head offices to 11, Haymarket, S.W.1, which are under the personal charge of their principal, Mr. Henry M. Wells.—Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, state that on and after December 7, the temporary address of their "Engine Works" Department in London will be 3, Blenheim-street, New Bond-street, London, W. 1.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Although war contracts continue to be cancelled and there has been a stoppage of orders since last week, business on the whole is distinctly improved, and there is every reason to take a hopeful view of future prospects. The transition from war to peace will be effected in Sheffield much more easily and rapidly than in many other industrial centres. The material and tools which Sheffield produces are the basis and essential of every industry, without which they cannot carry on. The volume of these requirements is tremendous. During the war Sheffield has increased her capacity to a remarkable extent and prospects tend to show that her output will only be limited by the supply of labour. At present a certain amount of slackness exists, as was inevitable in the changing-over period, but new orders are coming along, not only from the home market but to a large extent from abroad, and once the works have settled down to the changed conditions, a new era of prosperity is assured. Chief among the new work are orders for railway and marine steel, forgings, crucible steel, saws and tools of all descriptions. The pig-iron market is somewhat unsettled owing to the uncertainty as to the Government's intentions. Should the subsidy arrangements be withdrawn, prices will advance, and it is not surprising that at present there is little buying of raw, or semi-raw materials, except for immediate requirements. There are definite signs of a steady overseas business in the immediate future, heavy inquiries for sheep shears, sickles and tools having been received from South American consumers.

South Yorkshire Coal Trade.—But little improvement is observed in the local situation. The output is still affected by the prevailing epidemic and pits are turning out far under their normal tonnage. Merchants find exceeding difficulty in obtaining supplies of house fuel, and in many instances deliveries are months behind. For manufacturing fuel the demand continues considerably in excess of the supply, and so far, the reduction in tonnage consumption of munition works has had but little observable effect, although works generally are obtaining supplies with more freedom. Government requirements show no sign of falling-off. The export trade to France and Italy is larger than ever. Stocks of gas fuel are at a low level, and there is the utmost pressure from inland works for supplies. The market for slacks is steady, and all qualities are in brisk request. Coke is selling well at maximum rates. Quotations are:—Best branch handpicked, 27*s.* to 28*s.*; Barnsley best Silkstone, 27*s.* to 27*s.* 6*d.*; Derbyshire best brights, 25*s.* to 26*s.*; Derbyshire house coal, 22*s.* 6*d.* to 23*s.* 6*d.*; best large nuts, 22*s.* 6*d.* to 23*s.* 6*d.*; small nuts, 21*s.* 6*d.* to 22*s.* 6*d.*; Yorkshire hards, 22*s.* 6*d.* to 23*s.* 6*d.*; Derbyshire hards, 21*s.* 9*d.* to 22*s.* 9*d.*; best slacks, 18*s.* to 19*s.*; seconds, 16*s.* to 18*s.*; smalls, 13*s.* to 14*s.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Interest centres in the announcement of the Ministry of Munitions concerning the fixing of export pig-iron prices, and the withdrawal of subsidy to pig-iron producers at the end of April next. The official list of export prices is not yet to hand. The continuance of the subsidy to pig-iron makers to the end of April covers the period over which the Government is pledged to leave wages undisturbed. It is felt that some check is necessary to consumers attempting to anticipate ultimate rise in prices by laying in big stocks of pig-iron during the period subsidy is being paid. Home demand for both foundry and forge Cleveland pig-iron is large, and deliveries would be heavier if facilities for distribution were better. Sellers are not pressing forge quality on the market, though supply is plentiful, and buyers are prepared to make forward contracts. Supplies of Cleveland pig-iron are going steadily forward to the Allies.

Hematite Iron.—Nothing new of moment is noticeable in the East Coast hematite department. Under the system of official supervision deliveries to consumers are ample, but are not such as to permit of stocks accumulating. Sales to France and Italy continue through the channels arranged for supplies to the Allies.

Foreign Ore.—Some further expansion of trade in foreign ore is noticeable. Notwithstanding the considerable stocks held by consumers, and the fact that imports on current contracts are on quite a satisfactory scale, buyers are in the market and seem keen to place further orders on forward account.

Manufactured Iron and Steel.—Some of the smaller works are feeling the effects of the transition period, but the big plant is as busily engaged as ever on heavy work, demand being unabated for shipbuilding equipment, constructional steel, and railway material. Some rather large contracts for steel rails are understood to have been placed. Subsidies to steelmakers it is understood, are to be withdrawn after January 31, when a revised schedule of maximum prices will come into operation. Meanwhile, home quotations are unchanged, but a new schedule of export prices includes:—Steel ship plates, 16*l.* 10*s.*; steel ship angles, 16*l.* 2*s.* 6*d.*; steel boiler plates, 17*l.* 10*s.*; chequer plates, 18*l.* 10*s.*; steel joists, 16*l.* 2*s.* 6*d.*; and billets, 13*l.* 10*s.* to 15*l.*

Shipments of Iron and Steel.—Official returns show little variation in the volume of export trade at the port of Middlesbrough for the past three months. Shipments of iron and steel for November total 38,832 tons, as compared with 36,622 tons for October, and 36,317 tons for September. Pig-iron cleared last month reached 31,070 tons, as against 29,092 tons in October and 29,579 tons in September, the increase being due to heavier coastwise clearances which are given at 9,264 tons—a record for the year. Of manufactured iron and steel despatched 1,755 tons went coastwise, and 6,007 tons foreign, a total of 7,762 tons, which compares with 9,530 tons in October and 6,738 tons in September.

Management of South Durham Steel and Iron Company.—With the end of the war, Mr. Charles J. Bagley, who has successfully managed the affairs of the South Durham Steel and Iron Company, Limited, since its inception twenty years ago, retires. Previous to the formation of the company, Mr. Bagley had managed for sixteen years one of the works absorbed by the new undertaking, so that his connection with the works has extended over thirty-six years. Mr. Bagley, who remains on the Board of Directors, is succeeded in the management by Mr. Benjamin Talbot.

Coke.—Coke continues very strong. There is considerable scarcity for many purposes, but supply for use at the blast furnaces is ample. Average furnace quality is 33*s.* at the ovens; and low phosphorus kind 35*s.* 6*d.* at the ovens.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—The demand for coal is considerably in excess of the supply, and the docks are again in a state of congestion. The outputs are steadily improving as there are more men being employed; they now amount to close on a rate of 1,000,000 tons per week, but they are still below the pre-war normal figures. There is no relaxation in the pressure of official business, although a larger proportion is being despatched to allied destinations. Hitherto the proportions have been about 30 per cent. on Admiralty account, 15 per cent. for Allies, 5 per cent. for bunkers, 5 per cent. for destinations other than allied, and 45 per cent. for the home market. These proportions, however, have now been slightly modified, but the quantity available for ordinary private trading is still comparatively small. Only on rare occasions are coals being released for shipment for neutrals. The Coal Controller is stated to be contemplating a further restriction in the inland deliveries for works' consumption, but so far no official instructions to this effect have been issued locally.

Newport.—Very active conditions prevail on the market for Monmouthshire coals. The demand both for inland consumption and for export is extremely heavy, and with tonnage still abundant many vessels are awaiting their turn at the loading berths at the Alexandra and other docks. Smalls are finding a readier market than they have done for some time past, with coking and bunker qualities becoming more and more scarce. The authorities continue to absorb the bulk of the large coal outputs of the Eastern and Western Valleys. For inland consumption the railways are pressing for increased deliveries, and arrangements are being made for an augmented supply of about 20,000 tons per month. Neutrals are inquiring for supplies, but they are not available, except for exchanges essential to the interests of the country.

Price of Coal for Neutrals.—Under the schedule of coal prices issued by the Coal Controller a few weeks ago, a minimum price of 50*s.* per ton was fixed for best South Wales Admiralty steam coals and 70*s.* for best Newcastle large steam coal. Attention has been called to this anomaly, and it is now reported on the local markets that the Controller contemplates an early revision of neutral prices with a view to the scheduling of Cardiff and Tyne prices at values more closely related to the commercial qualities of the two coals. The present disparity has resulted in a diversion of neutral orders from the Tyne to South Wales, and in several cases orders are being placed for supplies within the period of three months, which is the limit laid down in the Controller's directions.

Italian Coal Imports.—A good deal of perturbation has been caused in South Wales by the report that the Italian Ministry has presented for the approval of Parliament a Bill by which it obtains the monopoly of the sale of coal. It is pointed out that thus at one blow the Italian Government not only promises to ruin the thousands of importers, merchants and dealers in Italy, but also to strike a very serious blow at the coal exporters in this country, since it follows that by far the greater portion, and probably all, the coal will be purchased either through the offices of the Italian State Railways already existing in Cardiff, or through a similar office to be established specially. It is understood that the central executive for the supply of coal to Italy have the matter in hand, and that energetic action is being taken with a view of safeguarding the interests of exporters. A movement has been set on foot to form at once a South Wales coal-exporters' organisation so that exporters may give collective expression to their views. It is pointed out that the article to be monopolised by the Italian Government is essentially a British production, and that the British Government should therefore be asked to protest against such a scheme both in the interests of the trade, and of the numerous firms concerned.

Another Colliery Deal.—It is officially announced that Messrs. S. Instone and Co., Cardiff, have acquired the controlling interest in the Askern Coal and Iron Company, Limited, and it is understood that the deal involves about 500,000*l.* Over 1,000,000 tons of coal can be dealt with annually by the present equipment, and the estimated reserves are over 200,000,000 tons. The area comprises about 8,000 acres, while more than 1,000 men are employed.

NOTICES OF MEETINGS.

THE MINING INSTITUTE OF SCOTLAND.—Saturday, December 7, at 3 p.m., in the Royal Technical College, George-street, Glasgow, Mr. Stewart Chambers' paper on "The Repair of a Circular Shaft of Small Diameter" will be discussed; Mr. John A. Yeadon's paper on "The Economy of Briquetting Small Coal" will be discussed; a paper on "The Training of Engineering Apprentices," by Professor Hardwick, will be submitted and discussed; Mr. David Penman's paper, "A Digest of the First Report of The Mines Rescue Committee," will be discussed. [These last two papers will only be discussed if they are in the hands of members prior to the date of meeting.] A paper will be read by Mr. P. A. Mossay on "Cooling of Electric Motors with Special Reference to Totally Enclosed Motors."

THE BRITISH FOUNDRYMEN'S ASSOCIATION: LANCASHIRE BRANCH.—Saturday, December 7, at 4 p.m., in the College of Technology, Manchester. Mr. S. G. Smith, of Manchester, will give a paper (illustrated by lantern slides) on "The Smelting of Cleveland Ironstone."

THE ROYAL SOCIETY OF ARTS.—Monday, December 9, at 5 p.m., Cantor Lecture: "Physical Chemistry and its bearing on Chemical and Allied Industries." By James C. Philip, O.B.E., M.A., D.Sc., Professor of Physical Chemistry, Imperial College of Science and Technology (Lecture II). Wednesday, December 11, at 4.30 p.m., Ordinary Meeting: "The Work of the British Army Veterinary Corps at the Fronts," by Major-General Sir Frederick Smith, K.C.M.G., C.B., F.R.C.V.S. His Grace the Duke of Portland, K.G., G.C.V.O., will preside. The paper will be illustrated by cinematograph views and lantern slides.

THE SURVEYORS' INSTITUTION.—Monday, December 9, in the Lecture Hall of the Institution, when a paper, entitled "The First Report of the Committee dealing with the Law and Practice relating to the Acquisition and Valuation of Land for Public Purposes," will be read by Mr. J. D. Wallis, Member of Council. The chair will be taken at 5 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Tuesday, December 10, at 7.30 p.m., in the Rooms, 207, Bath-street, Glasgow, when Mr. J. H. Shaw will read his paper on "The Use of High-Pressure and High-Temperature Steam in Large Power Stations."

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—Wednesday, December 11, at 7.30 p.m., at St. Bride's Institute, Bride-lane, Fleet-street, E.C., a paper will be read by Mr. J. H. Anderson, M.I.Min.E., on "The Winning and Transport of Fuel," illustrated by lantern slides. Mr. W. H. Booth, F.G.S., M.Am.S.C.E., in the chair.

THE INSTITUTION OF RAILWAY SIGNAL ENGINEERS.—Thursday, December 12, at 2.30 p.m., at St. Pancras Midland Grand Hotel, the discussion on Mr. H. M. Proud's paper, "A Graphical Method of Solving Direct-Current Track Circuit Problems," will be continued, and, if circumstances permit, Mr. Proud will reply.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, December 12, at 6 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. there will be a discussion on "Notes on Arc Welding Regulations," by Mr. H. M. Sayers. Copies of the paper can be obtained on application to the secretary. It is not intended, however, to limit the discussion to "Regulations," but that it should cover "Electric Welding" in general.

THE OPTICAL SOCIETY.—Thursday, December 12, at 7 p.m., at the Imperial College of Science and Technology. The following communications will be submitted for consideration: (1) "An Empirical Formula for the Longitudinal Spherical Aberrations in a Thick Lens," by Instructor Commander T. Y. Baker, R.N., and Major L. N. G. Filon, R.A.F.; (2) "Spirit Levels," by Major E. O. Henrici, R.E.

THE INSTITUTION OF WATER ENGINEERS.—Friday, December 13, at 2.15 p.m., at the Apartments of the Geological Society, Burlington House, W., the following papers will be read and discussed, viz.: (1) "The Relation of Rainfall to Configuration," by Mr. Clare Salter, Joint Director of the British Rainfall Organisation; (2) "Stream Flow and Percolation of Water," by Mr. Samuel Hall (Belfast); (3) "The Freezing of a Reservoir Outlet Works," by Mr. Gilbert Christie (Irvine and District Water Board).

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: NEWCASTLE BRANCH, TECHNICAL SECTION.—Friday, December 13, at the Connaught Hall, Newcastle-on-Tyne, a paper will be read on "Gearing and Gear Cutting," by Mr. C. Johnson.

THE WORLD'S LARGEST OIL-TANK STEAMER.—A notable addition to the oil tank fleet of the Eagle Oil Transport Company, Limited, was successfully launched on the 3rd inst., at the yard of the builders, Swan, Hunter and Wigham Richardson, Limited, Wallsend-on-Tyne. The vessel—the San Florentino—is designed to carry a total deadweight of 18,000 tons and is the largest oil tanker afloat; she is 546 ft. in length, 68 ft. 7 in. in width, with a moulded depth of 42½ ft. The hull of the ship is divided into 13 oiltight compartments and fitted with 4½ miles of oil pipes; the system of piping is so arranged that the pumps can discharge the vessel by grouping together a given number of oil holds in every conceivable way. Four different grades of oil can be either loaded or discharged simultaneously without getting mixed. The engines consist of a set of compound geared turbines.

FLOATING ELECTRIC POWER STATION.

(*For Description, see Page* 644.)

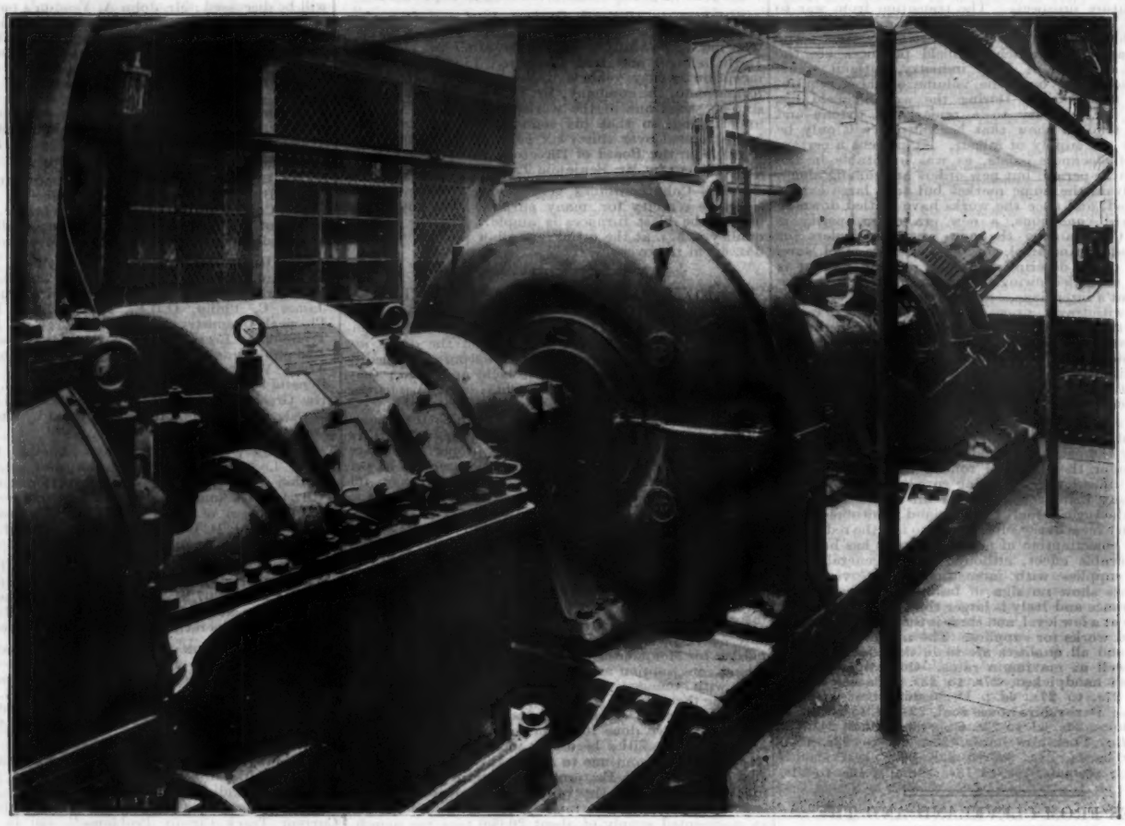


Fig. 5. Turbo-Generator in the Aft Dynamo Room.

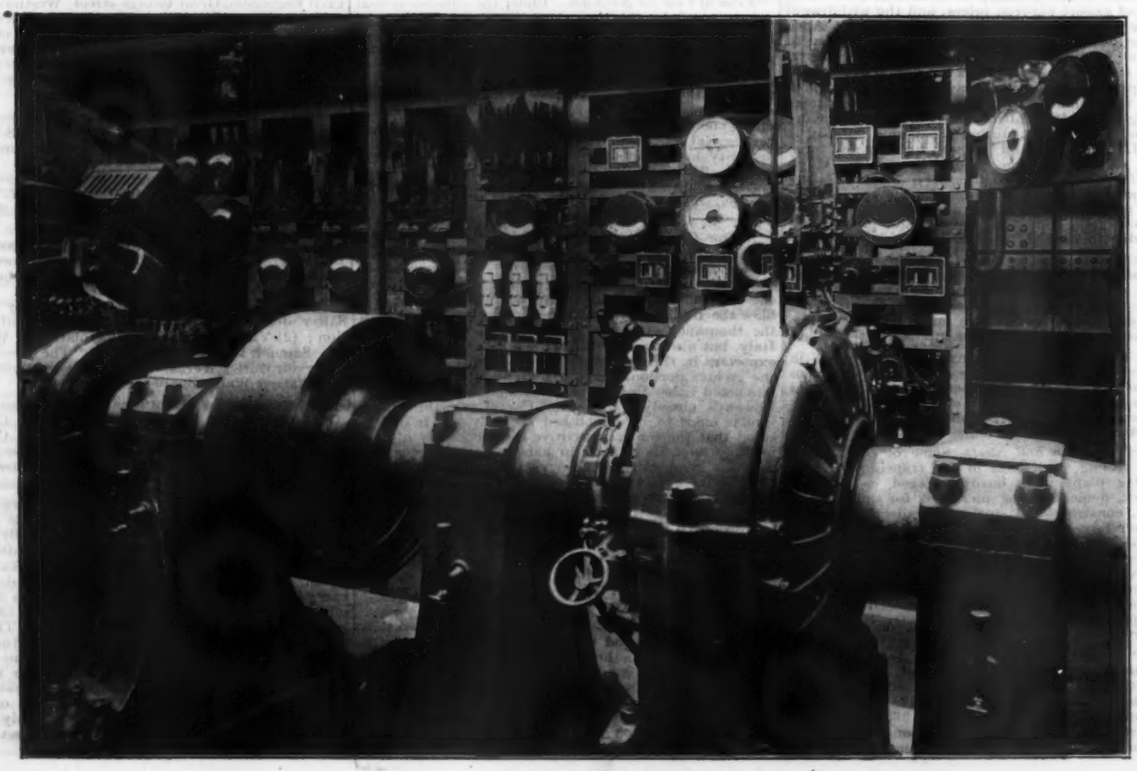


Fig. 6. The Switchboards.

1,500-TON TWIN-SCR HO

CONSTRUCTED FROM THE DESIGNS OF MESSRS. WILLIAM SIMONS AND MITED

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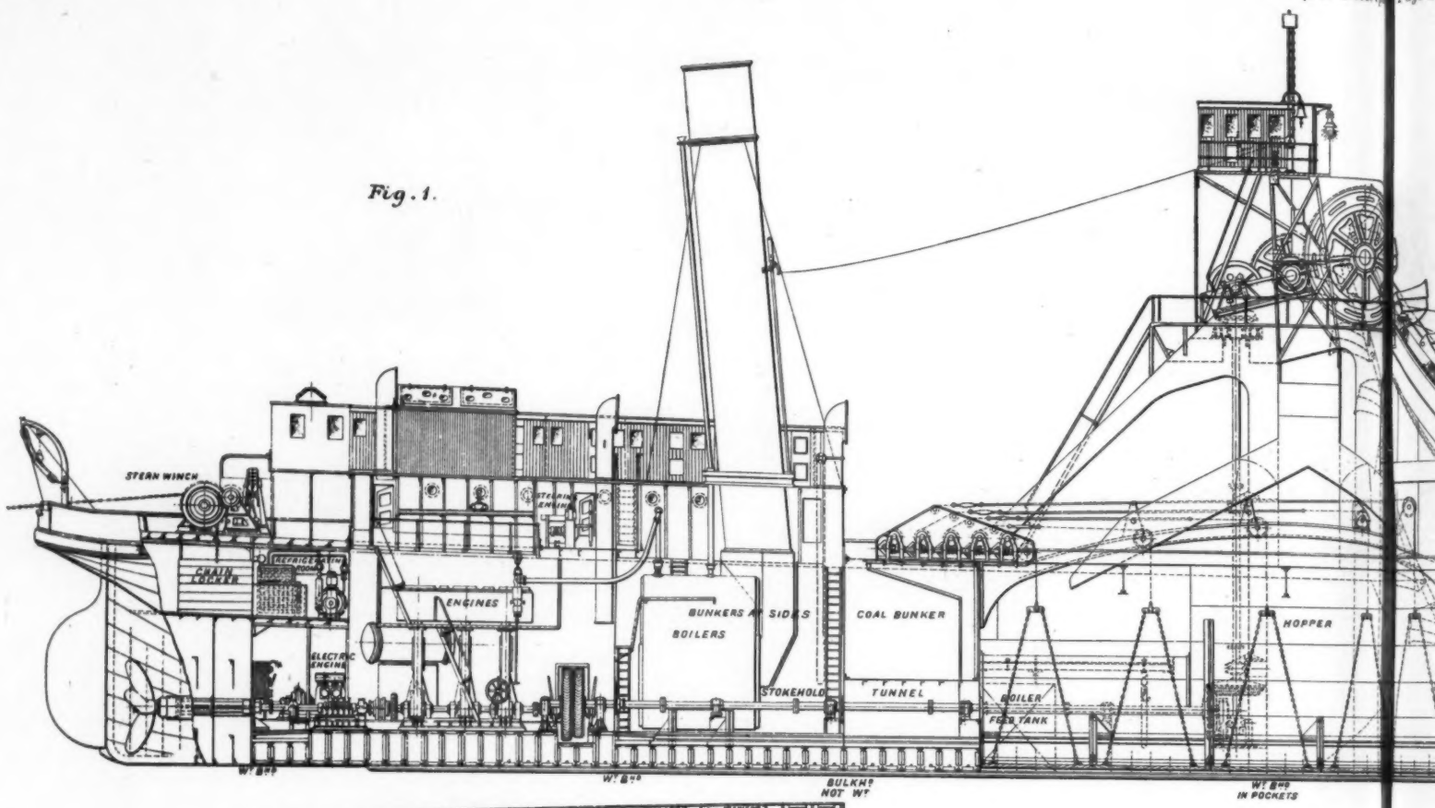

Fig. 2. SHELTER DECK

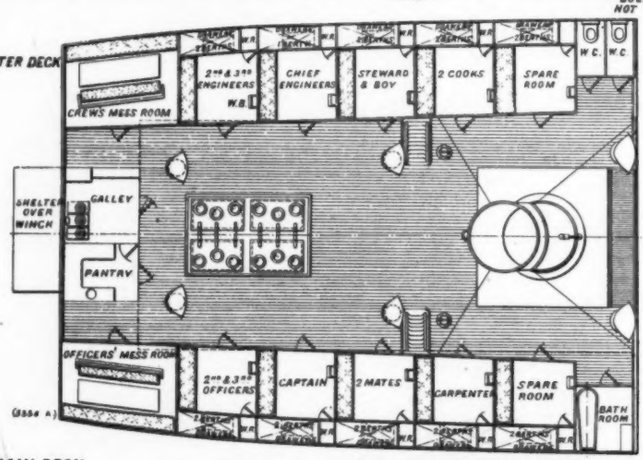

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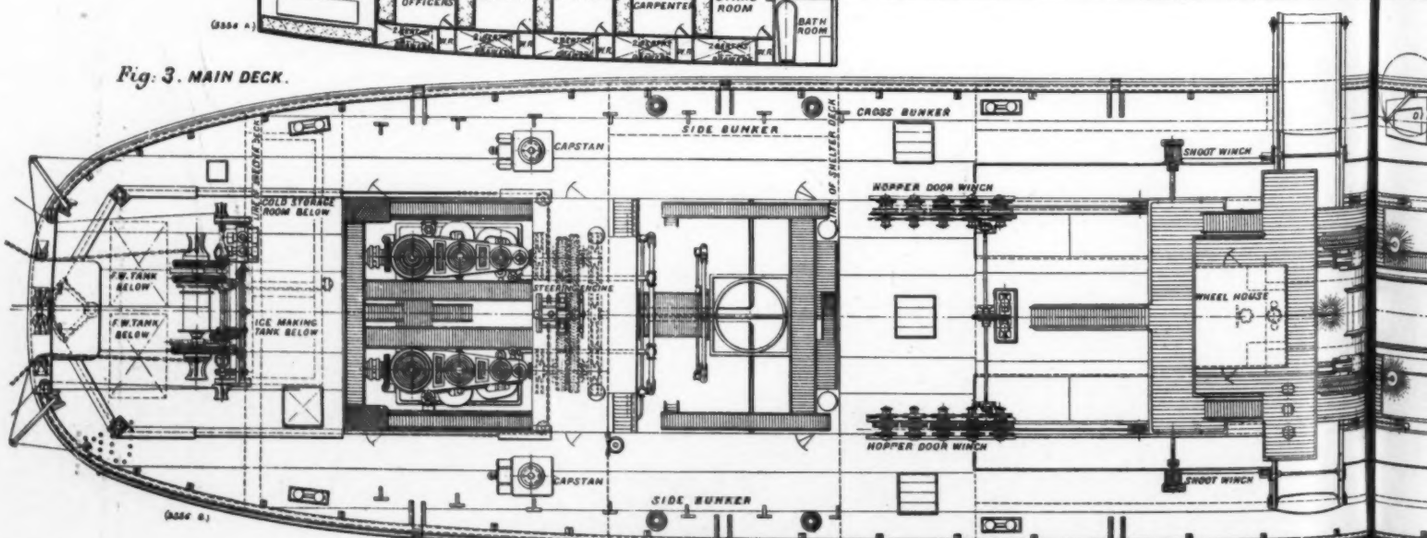
Fig. 3. MAIN DECK.



CR HOPPER DREDGER.

AND MITED, RENFREW, BY THE CANADIAN VICKERS COMPANY, MONTREAL.

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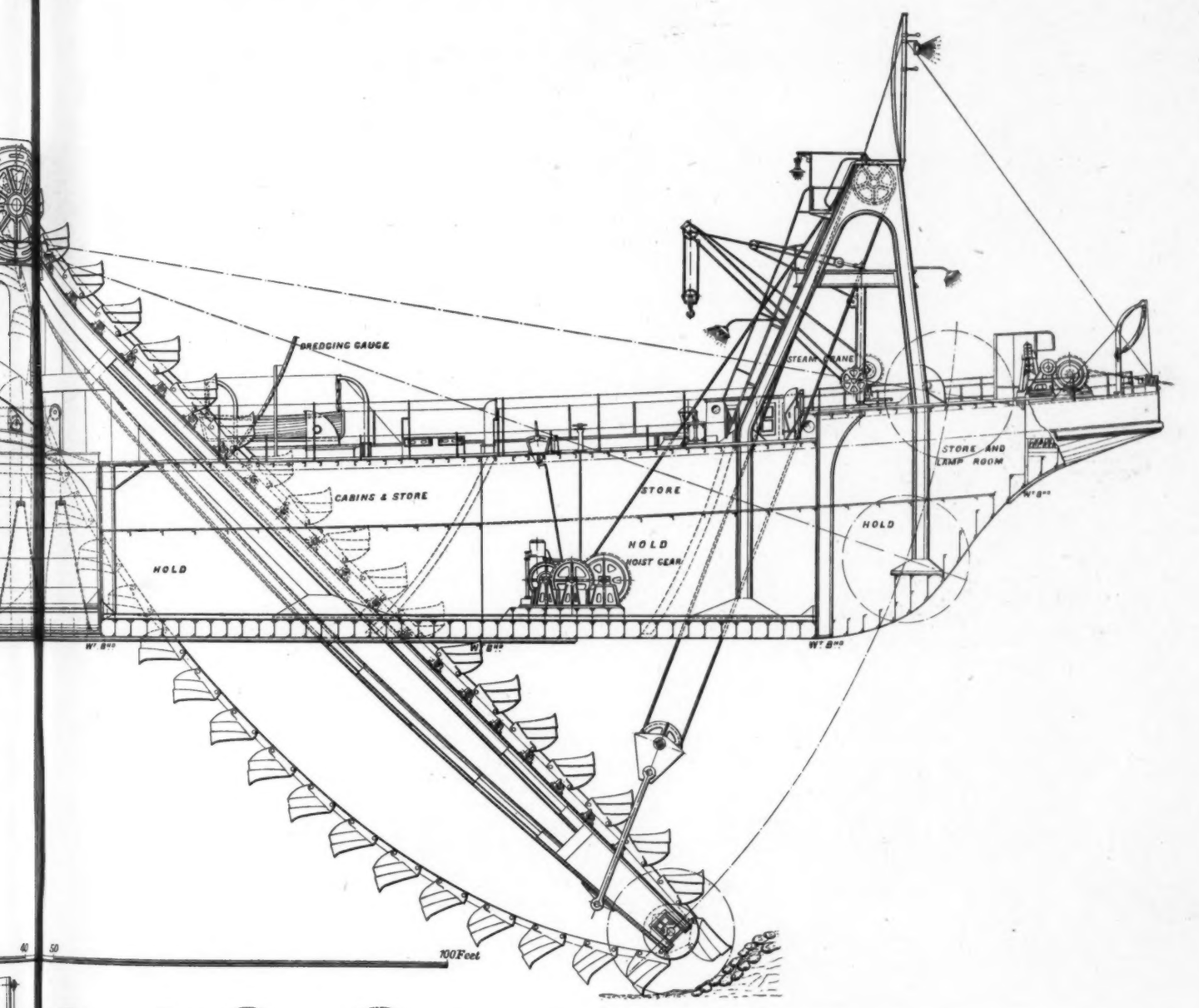

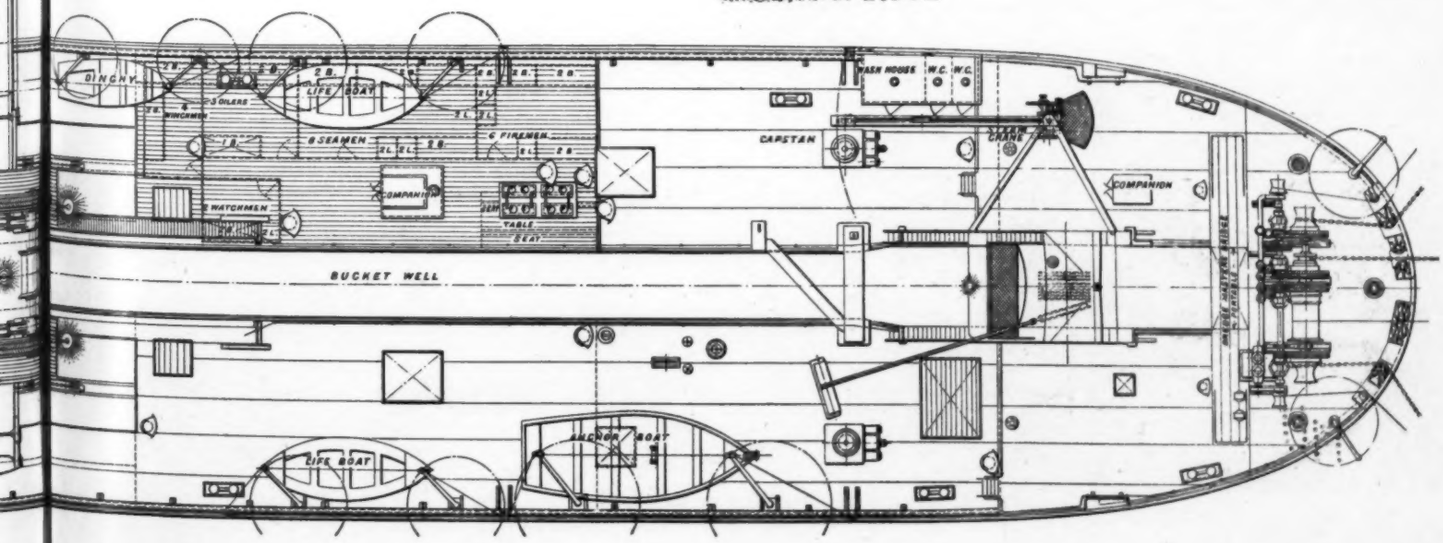

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Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than Monday morning.

SUBSCRIPTIONS, HOME AND FOREIGN.

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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3663 and 8596 GERRARD.

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NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal further from 8d. to 9d. per copy. This increase dates from and includes the issue of Friday, March 1, 1918. The change will not apply to unexpired subscriptions. The revised rates for new subscriptions are given in the adjoining column.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper and the consequent shortage of supplies, Newsagents will not have copies for chance customers: therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 647.

ENGINEERING.

FRIDAY, DECEMBER 6, 1918.

THE IMPONDERABLES.

LONG years ago, when in the hey-day of his business career, Mr. Andrew Carnegie is reported to have observed that he could better afford to face the destruction of his vast works than the ruin of his organisation, the efficiency of which had been secured only by careful selection and elimination extended over a long course of years. The works and their equipment could be replaced far more easily than the staff. The imponderables in fact outweighed in value the material. It is the same fundamental truth that Mr. A. A. C. Swinton had in mind when, in his recent presidential address to the Society of Arts, he insisted that the greater part of the capital of the civilised world is indestructible, since it consists not in mere structures and tools, but in the "know how" which civilisation has inherited from the original thinkers of many past generations. Probably Mr. Swinton is correct in holding that little useful knowledge has ever been lost. Rome was overrun by barbarians, but her knowledge of the arts, to which we owe many of the amenities of civilised life, persisted. This knowledge, with the prodigious additions since made to it, was no doubt painfully acquired. Many a blind alley was fruitlessly explored before the true line of advance was detected; but the work once done remains done, and as a consequence we shall be able to replace the material losses of the war at the cost of much less effort than was expended in producing the originals. It is curious and noteworthy that it is the exponents of pure and applied science who are so insistent on the importance of the non-material. Our modern self-styled idealists, who degrade an hitherto honourable title, commonly speak and act as if economics were unadulterated materialism.

To a certain extent, of course, we are all to-day advocates of science and of scientific method. The value of science has been too conclusively demonstrated to be ignored, and as Mr. Swinton observed, even the Labour Party joins in the chorus which is acclaiming its importance. We are, however, inclined to question whether Mr. Swinton was correct in holding that the gibe with which Lavoisier was sent to the scaffold could not be repeated to-day. In fact, the Bolshevists, unless they are greatly maligned, would rejoice at the opportunity of massacring many of our leading engineers and physicists. Moreover, it is greatly to be feared that much of the tribute to science now in fashion is merely lip service. The gulf between the methods of the engineer and scientific man and those of the popular politician is too wide for there to be much mutual sympathy, and it would appear from an address made some time back by the eminent American bridge builder, Dr. Waddell, that matters are little, if any, better in the States than here. The engineer wants to know how things actually do work in practice. If, for example, a proposal is made to nationalise an industry, he is unmoved by even the most eloquent forecasts as to the advantages to be gained, but asks how have similar predictions of prosperity been fulfilled in the past. Have, for example, the actual financial results of the nationalisation of the telegraphs borne out the prophesies of fifty years ago, and have prediction and realisation accorded any better in other equivalent cases? Another question by which the sincerity of the conversion of politicians to a belief in the methods of science may be tested is their attitude towards the manufacture of arms by private firms. Any fluent speaker can, with a minimum of mental effort, build up a most eloquent argument against the existence of armament firms. If, however, instead of trusting to his imagination, he would apply the methods of science and find out what actually has happened in the past, he would soon recognise that eloquence in such a case is wasted effort. For many months 70 per cent. of the shell bodies used by the British in France were obtained from America, and France would have certainly been overrun had American law forbidden American firms to make munitions when their country was at peace. Such an example illustrates once again the futility of the belief that the human mind can arrive at workable truths by mere intuition or logic unchecked by observation or experience.

In spite of the favour with which science is now regarded in political circles, he would be a sanguine man who expected that any Parliamentary party will easily discard its traditional usages, in favour of the scientific method. Nevertheless, we do most profoundly believe that whatever the difficulty of persuading our prospective governing classes to abandon the methods of Plato for those of Bacon, the future of civilisation depends on the realisation of this fundamental change. In the matter of bridge design, that eminent French engineer, M. Rabut, has formulated the maxim that when it is possible to measure, we should never be content with a computation, no matter how plausible the assumptions on which it is based. A corresponding maxim might well be applied to the work of rebuilding and reconstruction with which the nation is now faced. That there is nothing new under the sun may be a trite saying, but it is nevertheless substantially true, and a parallel in past history can probably be found for most of the schemes for social and economic reforms that are now being advanced. The history of such parallels will afford far better guidance as to the ultimate outcome of such schemes than the most logical deductions from the most plausible of hypotheses. The world war has afforded some striking instances of how history repeats itself even under apparently greatly altered conditions. We have already referred in ENGINEERING to the fact that the failure of the submarine campaign might have been anticipated from the historical fact that the *guerre de chasse* had always been a failure in the past. Again, M. Bloch's theory, advanced some years ago, that under modern conditions the defence had overwhelming advantages over the attack, has been proved false, and the teachings of history have been confirmed that impregnable lines of defence never have existed and probably never will.

A first step towards the introduction of the methods of science into policy should be the broadening of the basis of education. The past specialisation in classics must be abandoned, but care must be taken that it is not replaced by an equally deplorable specialisation in scientific studies. In this matter we should be inclined to go further than Mr. Swinton, who suggests that we might have both great classics and great poets without the smaller fry. It is perhaps doubtful whether this view is correct. Great men in every department of human activity are seldom isolated pinacles, but emerge like Mount Everest from amidst a vast mass of lower eminences. On one point however, we most cordially agree with Mr. Swinton, and that is that of recent years far too much importance has been attached to laboratory work.

Mr. Swinton laid emphasis on the increasing intricacy and elaboration of the technical side of our industries. Undoubtedly the proportion of total expenditure devoted to what the accountant calls non-productive ends will have to be very

greatly increased, but our recent experiences have shown us how profitable such expenditure may be. Methods of executing work have, during the past four years, received much more study than ever before, and as one result women have been enabled to turn out every variety of ammunition from 3-in. and 9·2-in. shells up to machine guns and fairly heavy ordnance. Outputs have, moreover, been attained which in pre-war times would have been considered incredible. Woolwich, of course, did little. The type of organisation usual, and perhaps unavoidable in the public services, is not such as to encourage originality, and indeed none of the private firms who were accustomed to make shells before the war have equalled the output of 9·2-in. shells reached in a certain south country works in which a shell had never even been seen before the war. Yet this shop, using female labour exclusively, but of course under highly capable male direction, easily surpassed every previous record in the production of this variety of munition.

For many years past there has been a section of the community which seemed to consider that to make a profit was a misdemeanour and to make a large profit was a crime. How efficiency is to be maintained and new industries built up without exceptional men reaping exceptional rewards is a problem to which the school in question has never attempted an answer. Mr. Swinton points out that no industry is in a healthy condition, or in a position to advance and increase, unless it makes good profits. The 20,000,000 tons of shipping which, together with the extraordinary development of the American steel industry, enabled us to beat the Hun, had both their origin in large profits, which were ploughed back into the business because the business was profitable. Otherwise, any savings made would have been invested elsewhere. Further, no firm which is not making large profits is prepared to spend money on experimental work. The drawn wire filament lamp, which has made electricity more than ever the poor man's light, originated directly in the large profits made by the General Electric Company of America. A firm struggling to pay its way could never have financed the long series of investigations which were essential to the solution of this problem. Progress and profits are closely connected, but still more important is it that our industries should remain under individual direction and control. We have had co-operative societies engaged in manufacture for many decades, yet not one has made any notable addition to our capacity to control nature or tap new sources of wealth. Whilst individuals have given us the steam turbine, the pneumatic tyre and wireless telegraphy, the co-operative societies have been content to be little more than parasitic on the thought and enterprise of others, not having originated a single great industry throughout the whole course of their existence.

PATENT LEGISLATION.

A year ago we reviewed the chief features of a Bill to amend the Patents and Designs Act, 1907, that had recently been introduced into the House of Commons by the President of the Board of Trade. The Bill was stillborn: but the contemplated legislation is to be revived and a new Bill will be introduced in the ensuing session of Parliament. A regrettable loss of time has taken place, and it is to be hoped that the Government will see that the new Bill is introduced and passed into law as quickly as possible. Industrial progress is based on invention, and invention must be encouraged. The reward offered by the State to inventors takes the form of a monopoly for a term of years, and such monopoly must be of a kind to encourage capitalists in developing commercially the inventions in which they are invited to take an interest. Without capital few inventions can be developed or even made. At no time can monopolies in the form of Letters Patent be regarded as gilt-edged securities, but it is possible by legislation to give such monopolies a greater value than is now the case. The new Bill can, if properly drafted, go a long way in the direction of making property in patents more valuable, and it is to be hoped that the authorities will do what they can to this end now that they have an opportunity of looking upon the question from the point of view at which it should be looked, which is that of the industrial world.

The Bill which became abandoned was subject to much criticism, and at the time it was introduced into Parliament we did not hesitate to express our opinion of several of the new provisions it contained. The Institution of Electrical Engineers appointed a committee to consider the Bill, and this committee has issued a report, which is a very illuminating document and one on which they are to be congratulated. We are in accord with almost all, if not the whole, of the report. The committee is further to be congratulated on the fact that, subject to a few verbal alterations, this report has been adopted by a conference of representatives of some 30 of the leading scientific and technical societies convened by the Institution of Mechanical Engineers. A representative deputation waited upon the President of the Board of Trade in October last, when the report formed the basis of the representations made by the deputation, and as a consequence it should carry far greater weight with the authorities than a collection of reports submitted by individual societies and persons.

Before dealing, however, with the report to which we have referred, we should like to call the attention of patentees to a very important matter which affects their interests in other countries. In France, on May 27, 1915, a law was passed which provided that the time for payment of patent fees on existing patents and the effecting of workings due subsequent to August 1, 1914, was extended until a date after the war. The law also granted the same suspension to the payments to be made when filing applications for patents. These extensions were only granted to subjects of countries which granted reciprocal rights to French citizens. Certain other countries have taken very similar action. Many British inventors have been holding up the filing of their foreign applications and the payments of the annual fees in the belief that they came within the benefits of the foreign enactments, but it is very doubtful if they do. The French law to which we have referred more particularly grants a legal extension or suspension, and calls in effect for a like legal extension or suspension in other countries. In this country, except with regard to the working of patents, there is no legal extension or suspension for the payment of patent fees. It is true that the Comptroller has been empowered, in certain cases, to grant concessions, but the concessions depend entirely upon the inventor or patentee being in a condition to state that his case comes within certain specified exceptions. To our mind this is not true reciprocity. The United States Government have been looking into the matter, and they have sent a delegate to Europe to investigate with a view to the question being raised at the Peace Conference. So far as we know no action has been taken by our Government, and we think it extremely desirable that steps should be taken so that the question may be dealt with both in the interests of foreign inventors who desire to protect their inventions in this country and British inventors who desire to obtain protection abroad.

We will revert now to the report, or rather to some of the more important parts thereof, as we cannot deal with the whole of the matter contained therein. The first part deals with the question of a patents moratorium. Some eighteen months ago we suggested that the Crown should compensate patentees in cases in which they had been prevented from working their patents, owing to causes due to the war. The President of the Board of Trade, in his response to a deputation from the London Chamber of Commerce, expressed a view opposed to any extension of the life of patents generally for causes connected with the war and contended that such action would amount to making patentees a specially favoured class who alone were not to suffer by the war. It is satisfactory to note that the President of the Board of Trade has to some extent reconsidered his views, for he stated recently in the House of Commons that the new Patents and Designs Bill to be introduced in the ensuing session would contain clauses dealing with the life of patents whose working had been prevented during the war. The committee think, and so do we, that it would be far better to deal with this matter in a Bill entirely independent of the new Patents and Designs Bill. If extension of the life of patents whose working has been prevented during the war is to be granted, such extension of grant should take place immediately on the conclusion of peace. The simplest way of dealing with the matter would be to grant an automatic moratorium or prolongation of all patents. The abandoned Bill proposed that the extension should be applied for at the end of the patent term by way of a petition for prolongation of patent rights. This procedure is costly, worrying, and would take place in many cases long after the evidence it is necessary to produce was easily available. It may be thought that our suggestion of an automatic moratorium would unduly favour certain classes of patentees, but in the main it would be found that such was not the case. Such an automatic moratorium would only deal with patents now in force, but patents have expired during the war by lapse of time, and the owners of such patents should be granted an extension of their rights equal to that from the commencement of the war to the end of the ordinary life of such patents. A number of patents have also been taken out during the war, and the life of these patents should also be automatically extended for a period equal to that between the date of application and the end of the war. All classes of patentees would thus be dealt with on the same lines and none would be unduly favoured.

Clauses 1 and 2 of the abandoned Bill were intended to replace Sections 27 and 24 of the 1907 Act. Section 27 dealt with the working of patented inventions and Section 24 provided for the granting of compulsory licences under certain specified circumstances. Section 27 was introduced into the 1907 Act in order to compel foreign owners of British patents to work them in this country. It was thought that beneficial results would accrue from the introduction of this new principle into British patent law. We were sceptical at the time, and even now are greater sceptics with regard to compulsory working. The compulsory working section of the 1907 Act is to all intents and purposes a dead letter, and the proposal to amend the law on this point is a tacit admission by the Government that the present law is inoperative, and that the much-vaunted compulsory working clause did not do what it was intended to do. We do not think that any compulsory working clause will do what the advocates of this principle think it will. Under the 1907 Act it was possible for any person to apply for the revocation of a patent on the ground that the patented article or process was manufactured or carried on exclusively or mainly outside the United Kingdom. Clause 1 of the abandoned Bill contains a most unhappy phrase as it speaks of the abuse of monopoly rights. The phrase is peculiarly unhappy at the present time because there is great need to encourage and foster invention, so that this country may be in a position to compete successfully after the war. Five sets of circumstances are specified as constituting abuse:—

(*a*) Non-working on a commercial scale in the United Kingdom without satisfactory reasons.

(*b*) Prevention or hindering of working in the United Kingdom due to importation from abroad, by, or on behalf, or with the consent of, or without effective interference by, the patentee.

(*c*) Demands for the patented article in the United Kingdom not met to an adequate extent and on reasonable terms.

(*d*) Any trade or industry prejudiced by refusal of the patentee to grant licences on reasonable terms.

(*e*) Any trade or industry prejudiced by conditions attached by the patentee to the purchase or use of the patented article.

The Comptroller-General of Patents was provided with five remedies:—

(*a*) He might endorse the patent with the words "Licences of right" after which anyone could obtain a licence on complying with certain conditions.

(*b*) He might order the grant of a non-exclusive licence to the petitioner.

(*c*) He might, in certain circumstances, order the grant of an exclusive licence to the petitioner or to some other person.

(*d*) He might revoke the patent.
(*e*) He might make no order.

As we have said, we have always been sceptical with regard to compulsory working clauses. Should the new Bill contain such a provision as we have dealt with, we think it will be found that the law relating to compulsory working will be in a short time as dead as is Section 27 of the 1907 Act. We should like to see the compulsory working clause thrown overboard, and in this opinion we are in agreement with the committee. Compulsory working clauses have always been inserted with the idea of penalising patentees who adopt a dog-in-the-manger policy, but such patentees can be dealt with much more easily than by complicated and expensive procedure. If a patentee knows that if he does not supply the reasonable requirements of the public or prejudices any trade or industry by refusal to grant licences on reasonable terms, any person may apply to the Comptroller for the grant of a compulsory licence, the fear of such procedure will be amply sufficient to prevent a patentee holding up his patent rights to the damage of the public. The abandoned Bill contained improved machinery for the provision of compulsory licences, but it seems to us that Section 24 of the 1907 Act, if suitably amended so as to simplify the procedure thereunder, would provide all the protection that the public require. We suggest that the Comptroller be appointed the person to decide the matter, not the Board of Trade, and that an appeal be allowed to the Courts. The Comptroller is in a position to deal expeditiously with applications of this nature, and the procedure before him is cheap and does not involve the long delays or the great expenditure necessary when application has to be made to the Board of Trade or to the Courts.

Clause 11 of the abandoned Bill was intended to make it impossible to patent articles for food or medicinal or surgical purposes or capable of being used for the production of food, medicine or surgical appliances. Processes of making foods, drugs, medicines were, however, to be patentable. The drafters of this provision did not see or did not appreciate what they were doing. The effects of such a provision would be most drastic, and it is only necessary to mention that under such a provision it would be impossible to patent articles, such as (1) machinery capable of being used in bakeries or other food production; (2) surgical instruments and appliances of all kinds; (3) electric motors capable of being used for driving dentists' drills; (4) X-ray tubes and other X-ray apparatus; (5) machines and apparatus useful in the manufacture of drugs and medicines. It is to be hoped that in the period that has elapsed since the abandoned Bill was introduced the authorities have seen the error of their ways and will throw overboard such a drastic provision.

The committee are of opinion that the term of a British patent should be increased. At present, the term of a patent is fourteen years, and we agree that such term should be increased for at least two or three years more. The committee have also in their report set out an interesting statement with regard to the average surplus of receipts over expenditure of the Patent Office during the last ten years, and they use these figures as a plea for the reduction of the annual renewal fee on British patents. The amount of fees demanded by the Government for the grant of a monopoly are very much greater than those that obtain in some countries, though it must be stated that they are very much less than those in other countries. The annual fees on British patents could very well be reduced without causing the Patent Office to suffer an annual loss. It is a great many years since the fees were reduced, and in that time the number of patents applied for and granted has considerably increased. The Government has always appeared to regard the Patent Office as a revenue-producing office, but this is not the spirit in which the matter should be dealt with.

We hope in the new Bill that powers will be taken to improve and extend the official search as to novelty. Under the present law the office only has power to make an investigation through prior British patents, while in a court of law other published matter may be cited as anticipatory. The benefits which have resulted from the official investigation as to novelty have proved valuable to inventors and capitalists and the benefits would be much extended if the investigations were made broader. We have had pleas in the past for the adoption in this country of the American system of patent protection. We have never been certain what the proposers have meant by the American system of patent protection; if their plea is for an extended investigation, we are with them heart and soul, but if their advocacy of American patent protection is for the adoption of the whole system that obtains in America, then we are in opposition. It was commonly said in the past that the protection granted in America and in Germany was very much better than that which obtains in this country, because of the much broader investigation as to novelty made in those countries. If we are to improve the value of patent property something must be done in this direction, and we hope to see in the new Bill provisions to this effect.

INDUSTRIAL DEMOBILISATION.

THE next few months promise to be a difficult time for the manufacturer and his works manager. Especially does this apply to most branches of the engineering trade. Some shipbuilders and others following the track of war have not greatly wandered from the paths of peace, but the road has carried many far from the old highway and the familiar scene. It has been stated by Mr. Churchill that 60 per cent. of the people employed on munitions are working at the same industry they would normally be engaged in in times of peace. This figure at first sight seems high, but as far as engineering is concerned there is no reason why it should not be correct. It is not stated that 60 per cent. of the people are working at the same "job" they would be working on in peace time, merely that they are engaged in the same industry. It is the manufacturers' and works manager's duty to change-over this 60 per cent. from the machine gun to the ploughshare with as little friction and delay as possible, and at the same time to deal with the remaining 40 per cent., which by hypothesis is new to the engineering world.

From the point of the daily press and the public the 40 per cent. representing unskilled and semi-skilled labour, presents the most urgent problem, but it is doubtful if the disposal of this labour is really as urgent as the changing-over of the 60 per cent. to productive manufacture. The unskilled labour which may, and largely must, be displaced is covered for the present by the out-of-work payment scheme. The change-over of the 60 per cent. is the manufacturer's pressing problem. Much work will be involved in almost every shop, and usually it will be impossible to carry out the change immediately. Shops making, say, heavy gun mountings, will be able to tackle many classes of industrial machinery, but, unless plans are already made and preliminaries arranged, many months may be spent in negotiation and arrangement, to be followed by many more while drawings, patterns and tools are prepared. It is only after these are completed that the machine shops can begin. Most shops are not shell factories. They are quite capable of undertaking a variety of work, and the works manager is quite used to starting-up a new job. He has not, however, usually had experience of his whole line of manufacture suddenly coming to an end to be replaced equally suddenly by something else.

Shell and other special plants share the difficulties of more adaptable equipments with many problems of their own. Most of the important shell plants are either special factories built and equipped for the work, or special extensions of pre-war establishments. We gather that, broadly speaking, no one quite knows what to do with them. The machinery is of little present value. Estimates of this class are only guesses, but we suggest that not more than 20 per cent. of this machinery has a post-war manufacturing value. We say 20 per cent. with a desire not to overstate a case. The figure is probably considerably lower. It is the general wish and hope that these factories may carry on and fall into their places as units in the increased manufacturing capacity of the country. We see no reason why they should not, but these things take time, and for the moment one cannot help being much concerned with the present. One hopes the Engineering Trades (New Industries) Committee may ultimately do good work, but it can be little help in this problem of the moment.

We fear there is little doubt that most of the female and much of the unskilled labour employed on special munition plants will have to be disbanded. Manufacture on a gradually decreasing scale is to be carried on into the new year; but this is merely an expedient to prevent sudden flooding of the market. The labour will shortly have to be absorbed elsewhere, or will become idle. The female labour is probably a simpler problem than the male. We have seen no statistics of the pre-war activities of the women now engaged on munition work and imagine no general records are in existence. Figures for a large north of England factory are, however, probably not an unfair guide. In this establishment, engaged on engineering work, some 42 per cent. of the women were mill hands, 21 per cent. were in domestic service and about 21 per cent. were not occupied outside their homes before the war. In a factory situated in another part of the country the percentage of mill hands would no doubt be much lower, but the figures for domestic service and home occupations would probably be higher as a balance. The problem of the factory we have quoted will be largely solved on the female labour side as the cotton trade obtains more raw material, which should be at no distant date. The large proportion of domestic servants in this factory is probably fairly well paralleled all over the country. This labour we imagine can get back to its old occupation as soon as the units forming it have a mind to. The girls may still wish for the freer life of the factory, but if economic causes demand it they will go back to their old work. The women not occupied before the war can, in many cases, doubtless resume that position, at least temporarily, without hardship, and on the whole it appears that in the case we have taken the women munition workers should move back into their old grooves with little difficulty and no great delay.

The unskilled male labour is, we are afraid, a more difficult problem. A considerable proportion of it consists of discharged soldiers, while another large proportion is unskilled labour pure and simple. This labour will in course of time undoubtedly be absorbed to a large extent by retail shops, the post office, transport services and other of the great fields for unskilled labour. This re-arrangement will, however, take time, and some of this labour will certainly have to come on the out-of-work payment scheme. Male labour will, however, have one advantage over female in that a proportion of it can be employed in the changing-over of the factories. This should furnish an immediate field. Unquestionably the correct employment for shell and other war plants is to alter them at once into something else, and this alteration should absorb a fair proportion of the unskilled labour now free.

The question of the ultimate ownership of the National Factories is, of course, bound up with a discussion of the conversion of special war plants, and this question we do not at the moment wish to discuss. On broad lines, however, and independent of any question of ownership, there is no doubt that the proper use for special war plants will be in most cases to disband the machinery and start afresh. We have suggested that not more than 20 per cent. of the shell machinery has a manufacturing value now, and it is quite possible that the figure should be 5 per cent. The proper place for the useless, or relatively useless, plant is the melting pot, and on the whole the sooner it gets there the better. No doubt much of the machinery could be adapted for work different from that it has been doing, and as a temporary measure some of it may be thus employed, but this should be only an expedient of the change-over.

We have heard much, but not too much, of intensive manufacture, and the position of this country in the markets of the world. This question is no mere matter of political formulæ. It is a vital subject. In soap and pickles we may not have much to learn, but in many branches of mechanical

work we yet have far to go. At the present day we simply cannot afford to jog along with converted and more or less suitable plants. We must have specially-designed equipments ensuring the maximum output per employee at the minimum cost. It is into such manufacturing plants that we hope most of our shell and other special war factories and shops may be converted in the next couple of years. Only in this way can we absorb our surplus labour in a permanent way and do something towards paying for the war.

So far we have said nothing of skilled labour. It cannot be overlooked in an industrial demobilisation, but generally we think its disposal will be a matter of no difficulty to the works manager. We hope and believe he will want all he can get. Even in the special factories in which 20 per cent., or 5 per cent., only of the plant is of further use, the skilled labour—usually a small percentage of the whole—should be absorbed at once in getting the useful percentage of plant into a proper condition. Special cases there will be, but generally the works manager, after his long experience of shortage of skilled labour, will have no difficulty in employing all he has. It is unlikely that skilled labour will come on to the market to any considerable extent at all. Employers having such labour will be wise to keep it and employ it properly at once; partly because it will be difficult to get any more and partly to engender confidence in the labour that its position and prospects promise well. The average shop will want all the skilled men it can get for the change-over and the wise way to begin is to let those already there understand and believe that they are not affected by the necessary cutting-down of numbers. Their jobs simply go on as before.

"TONNAGE IS PROSPERITY."

The dramatic surrender of the German fleet and the consequent cessation of the submarine attacks on the world's merchant tonnage create an appropriate opportunity for a rapid survey of the effect of war conditions upon the shipping and shipbuilding industries of Great Britain.

As regards the shipping position, the outstanding fact is that the merchant tonnage available to-day is less by about 3,500,000 tons than it was just previous to the outbreak of war. Opportunity for the early replacement of vessels lost did not exist for the private shipowner, as not only were practically all the building facilities of the country taken over for the production of vessels for war purposes, but merchant vessels on the stocks at the outbreak of war were in many cases taken over by the Government and converted to war uses, while work on the remainder of the merchant vessels on the stocks was suspended. Serious as is the deficiency thus shown, it by no means represents the full extent of the losses which will have to be borne by this country as a direct result of the war. Many ships which were regarded as obsolete previous to the war had to be pressed into service owing to the dire necessity for tonnage, and these will have to be scrapped as soon as normal shipping conditions are re-established. Again, a very large number of high-class passenger liners, Channel vessels, &c., have been continuously engaged on patrol work, carrying troops, &c., the internal fittings and accommodation being partly or wholly gutted out for the purpose in view. This, combined with the hard and continuous service called for from these vessels, renders it extremely doubtful if many of them will be fit to resume their pre-war trade, while the design and construction of most of them render their conversion into cargo carriers economically impossible. The loss of tonnage from these causes will be a very serious item and falls to be added to the 3,500,000 tons deficit already mentioned.

Another aspect of the situation which calls for serious thought is the work of demobilisation. The transport of troops and stores must of necessity require the services of a very large number of merchant vessels of all classes for an indefinite period, but which period can hardly be much less than two years. This work will have to be carried out at a time when the services of these vessels would be of the very greatest value in carrying the essential foodstuffs and urgently required raw materials for the reconstruction of industry at home. During this period the utmost care will require to be exercised in order to ensure the greatest possible use being made of the available tonnage in the importation of the more urgently required raw materials. Whether this service would be better performed by Government controlled shipping is open to question, but there can be no doubt that there must be rigorous control and direction as to the nature of the cargo carried for a time at least. The losses sustained by the British mercantile marine have been relatively far heavier than those sustained by our competitors in the carrying trade of the world, while at the same time several of these competitors—notably America and Japan—have added very greatly to their pre-war tonnage and are thus in a most advantageous position to compete with us now and in the future. Not only is this the case, but many of our competitors among the neutral nations have, as a result of the demand for tonnage during the war and thanks to their relative freedom from Government interference in the matter of freights, improved their financial position and therefore their ability to acquire and run new tonnage in competition with us. This is especially the case with regard to the Dutch, Danish, Swedish and Norwegian shipping companies which were our very keen competitors in the tramp trades in pre-war days. To what extent the war has benefitted these companies financially it is, of course, impossible to say, but some figures given by Mr. Runciman in a recent speech in the House of Commons are instructive in this connection. Mr. Runciman stated that the capital of the more important Dutch firms has increased during the war from 98,000,000 florins to 123,000,000 florins, and that their reserve funds have increased from 28,000,000 florins to 148,000,000 florins. Mr. Runciman further stated that in spite of losses by mine and submarine the fleets of these companies actually increased during this time, while the reserve capital accumulated by Norwegian owners is such that they have been prepared to place orders with British builders at gigantic figures and to pay large sums on deposit. The limitation of freight charges and the incidence of the excess profits tax have naturally handicapped British owners in the accumulation of large reserves of capital, while the preoccupation of shipbuilders with naval work has made it impossible to replace losses or to increase tonnage. The British owners will be further handicapped by the fact that it will even now be quite impossible to replace lost tonnage at anything like the insurance value of lost ships.

The outlook from the British shipowners' point of view is therefore charged with the certainty that their efforts to re-establish the supremacy of British merchant shipping will be met by the strongest possible competition on all sides. How best to meet and overcome this competition is naturally best known to those who organised, developed and directed the operations of the shipping service which has rendered such signal service to the cause of Britain and her Allies and it is therefore specially gratifying to have the Government assurance that the normal conditions in the shipping trade will be restored at the earliest possible moment, subject to the provision of the prime necessities for reconstruction.

The first essential to the re-establishment of British shipping and to an early and adequate supply of essential foodstuffs and raw materials, and therefore to an early return to normal conditions of life, is an adequate supply of suitable ships—in the closing words of the manifesto issued by Lord Pirrie to shipyard workers "Peace is a question of tonnage, and tonnage is prosperity." The national prosperity therefore depends in large measure upon the efficiency of the shipyards and engine works of the country and upon the efforts of the workers of all ranks in the shipbuilding industry.

The outbreak of war had, as already stated, the immediate effect of creating an unprecedented demand for the urgent completion of war vessels building and the rapid construction of a very large number of new vessels for war service. Concurrently with this rush of work the industry sustained a very serious loss of young and able workers owing to the calling-up for service of Army and Navy Reservists and Territorials. Continued recruiting of skilled workers for the fighting forces caused a very serious shortage of labour and led to the agreement with the trades unions by which the principle of dilution of labour was accepted as a means of increasing output. The work accomplished under these conditions has been very creditable to all concerned, but it must be said that so far at least as the shipyards are concerned, full advantage has not been taken of the possibilities of diluted labour. With the growing success of the enemy's submarine and mine warfare, and the introduction of the convoy system for merchant vessels, a very large number of destroyers, patrol boats, mine sweepers, &c., were required, and in meeting this demand the shipyards have done splendid work. Continued success on the part of the enemy submarines in their attacks upon merchant shipping brought about the very serious losses which induced the Government to put in operation the scheme for the establishment of national shipyards, to adopt the policy of building standard ships in private shipyards, and to encourage private builders to increase the number of building berths in their yards. The establishment of the national shipyards has been hotly assailed on all sides, both from the point of view of policy and also from the point of view of the most efficient use of the man-power and materials available. Much has been said on both sides of the question, but there remains the insurmountable fact that a large amount of man-power was expended in making these yards and in the provision of materials for and erection of shops, machinery, &c., at a time when every shipyard in the country was in the most urgent need of men—skilled and unskilled. It is a fact that at that time many berths were vacant in our largest and best-equipped yards owing to lack of men to build ships, and it can hardly be doubted that from the point of view of rapid constructing of ships better use could have been made of the available labour and material in the old-established shipyards. The adoption of standard designs for merchant vessels initiated by the Shipping Controller at the end of 1916 was based on sound theoretical and practical considerations, but the practical application of the principle—especially in the early stages—gave results which could hardly be considered satisfactory. The designs adopted have been severely criticised by shipowners, while the lack of decision as to details of construction and fittings and the consequent alterations during building caused very considerable delay and did much to arouse the hostility of builders. Of these vessels, 145 were completed on November 14, 1918. The "fabricated" ships which it was intended to put together in the national shipyards have been sent for erection to private yards, but the number so far completed is small, one only being completed on November 14 last. The number of extra berths added to the private yards under the Government scheme is officially given as 87.

The signing of the armistice conditions on November 11 and the subsequent surrender of the German Navy has naturally caused a very considerable modification in the shipbuilding requirements of the country. The demand for naval vessels becomes less and the demand for merchant vessels becomes more urgent, and the demand has been made in some quarters that the building of warships should at once be stopped and partially-built vessels taken down in order to make way for merchant tonnage. It should, however, be borne in mind that no such proceeding is possible without causing very grave loss of money and a great deal of unemployment. Keel, frames, floors, bulkheads, &c., must be prepared on the ground before it becomes economically possible to lay down a vessel on the blocks and to employ a number of men on her construction, and some considerable time must elapse before the necessary material can be procured and the above work accomplished. Warships construction must therefore be carried on until it becomes possible to employ the labour on merchant work, and this time will vary in each yard. A very few months should, however, see all the yards fully employed on the construction of merchant tonnage, and as all the more important yards have been fully employed on warship work the result of the change-

over should soon be apparent in the output of new merchant tonnage.

The post-war outlook for the shipyards is distinctly encouraging provided that labour problems can be satisfactorily dealt with. Many shipyards have extended their building capacity by the provision of new berths, machinery and equipment have been greatly improved, and more efficient methods adopted to meet the war-time demands. All these factors are bound to tell on the output of merchant ships in the immediate future and encourage the belief that British shipbuilding will shortly reassert and vindicate its claim to pre-eminence in quantity and quality of output.

QUARTZ, TRIDYMITE AND CRISTOBALITE.

In recent discussions on refractory materials and silica fibre bricks much has been made of the transformations of quartz into tridymite and cristobalite, and the ease of estimating the temperatures to which the firebricks have been exposed from the occurrence of the one or the other modification of quartz in them. It should be borne in mind that such statements are highly controversial. As long as almost every redetermination of the characteristic temperatures corrects previous data, it is hardly advisable to assert that a silica brick must have been heated above 1,470 deg. C., because cristobalite has formed in it, and to use quartz generally as "geological thermometer," as F. E. Wright and Larsen proposed in 1909. All quartz is SiO_2 in a relatively pure state. That formula, however, is not supposed to represent the true molecular weight of the mineral, and though there are good reasons to distinguish at least three modifications of crystallised quartz (each probably existing in two forms) differing as to solubility, density and optical properties, and differing also as to molecular weight, which is unknown, and very possibly as to purity, we are not at all clear concerning the conditions of the transformations. In its most common crystallised forms quartz is hexagonal or rhombohedral and has the density 2·65. The much rarer mineral tridymite is regarded as hexagonal, but the small crystals are almost exclusively found in hemihedral forms, in twins and triplets, as the name indicates; the density is low, 2·3. Cristobalite is considered pseudo-cubical; its density, 2·348, is a little higher than that of tridymite, with which it was first found (in 1887) associated on Mount San Cristobal, near Pachuca, in Mexico; hence the name. Cristobalite is called pseudo-cubical because the small octahedrons of the mineral, which likewise inclines to twinning, appear doubly refractive, but lose that property above 175 deg. C. The same peculiarity is, however, ascribed to tridymite, and most of the facts stated are uncertain; modern text books on mineralogy hardly mention cristobalite. Above 800 deg. C. quartz is unstable and said to turn into tridymite and finally into cristobalite (at 1,470 deg. according to Fenner); but even below 800 deg, quartz is known in two reversible forms, α and β. the β form appearing above 575 deg., and similar α and β forms are assumed for the other two modifications. The further peculiarity that quartz crystals are either right-handed or left-handed and turn the plane of polarisation to the right or left, is not connected with these α and β forms. In addition to these crystalised forms silica, more or less hydrated, occurs amorphous as opal (density 1·9 to 2·3); the other quartz minerals, chalcedony, agate, jasper, flint, &c., are regarded as cryptocrystalline mixtures of quartz with amorphous silica and impurities.

When natural or artificial silicates are dissolved or fused and decomposed with acids, the silica separates as a gelatinous mass which, dried, turns into an amorphous material of the properties of opal; the siliceous sinters, beautifully white and iridescent often, deposited by hot springs, are classed as opals. Starting from such silicates, from glass and also from ground quartz itself, crystals of quartz or of its modifications have been obtained by various means, in the wet and dry, by prolonged digestion for days or weeks, at temperatures above 200 deg., simply with water or with acids and chemicals, or by fusion with or without addition of alkali or salts. The reactions may yield one modification or several of them, side by side. How they are identified as such, is mostly not specified; the optical tests, often alone available, are disturbed by the fine fissures developing during the quenching of the specimens. A great number of such experiments have been made. Some of the experimenters seem to assume that the chemicals and minerals added will merely act as fluxes, though the extreme complexity of natural silicates might suggest that the products obtained, in spite of their resemblance to quartz, do not represent pure SiO_2 or a polymer of it, but rather compounds; the transformation temperatures and melting-points might, at any rate, be affected by the presence of other substances. The volatility of silica further complicates the phenomena. Tridymite has been discovered in the muffle of a zinc furnace; A. Lacroix did not observe tridymite in the Mount Pelée rocks soon after the eruption, but found it six months later, and Schwantke reported a case in which lightning had apparently produced tridymite from the volatilised silica of a slate roofing. As regards the reactions going on in the arches of steel furnaces the prolonged heating, alternating with cooling, and the pressures arising may be of more influence than the maximum temperatures attained; the transition quartz-tridymite is accompanied by an increase of 14 per cent. in the volume.

The most recent determinations of the melting-points of cristobalite and tridymite were conducted by J. B. Ferguson and H. E. Merwin (*American Journal of Science*, August, 1918) in the Geophysical Laboratory of the Carnegie Institution, Washington, where A. L. Day and F. S. Shepherd made the first determination in 1906. Heating finely-powdered quartz in an iridium furnace the latter observed melting, after gradual softening, at 1,625 deg. C., but they were not certain as to the modification involved. K. Endell and R. Rieke (Berlin Porcelain Manufacture, 1912) raised the melting-point of β-crystobalite, of density 2·33, to 1,685 deg., possibly higher; they started from pure materials, relied on density measurements rather than upon optical tests, and observed that the rate of transformation (above 800 deg.) increased with rising temperature and with the surface development, twinned crystals and fibrous material changing much more rapidly than simple crystals; rapidly-heated quartz crystals seemed to melt without changing into cristobalite. C. N. Fenner (Geophysical Laboratory, 1912) lowered the melting-point of crystobalite to 1,625 deg. by very slow melting in a graphite crucible), but N. L. Bowen (Nov., 1914) confirmed Endell's higher figure, and Ferguson and Merwin now fix the melting-point of cristobalite at 1,710 deg. They arrange their vertical, double concentric furnace on the cascade principle; the outer furnace is an alundum tube wound with platinum wire, the inner tube of magnesia is wound with Pt-Rh alloy (20 per cent. rhodium); the specimen is wrapped in platinum foil and suspended from the thermocouple. The outer furnace is first heated up, the current then sent through the inner furnace, and the specimen is quenched in mercury after having been kept at the maximum temperature of the series for 10 minutes or longer. The materials used were quartz, silica glass, a calcium-magnesium silicate which has served for other rock studies, and natural and artificial tridymites. By heating a clear quartz up to 1,300 deg. and 1,400 deg. for 144 hours they turned most of it into cristobalite, but grains or traces of clear quartz were still left in the mass of white, friable cristobalite. In some experiments they converted, by heat alone, quartz into tridymite and this into dense grains of cristobalite, without melting; most other experimenters had made use of mineralisers in similar experiments. They also draw attention to two types of crystals which they obtained from glass furnaces; good tridymite crystals were found in the crown of a furnace, in which the direction of the flue gases was reversed every 20 minutes, whilst good cristobalite was found in the undoubtedly hotter portion of a recuperative furnace. In this respect they thus agree with Fenner—whose view we stated above—that the region of stability of cristobalite lies above that of tridymite, and they differ from H. Le Chatelier, who has based the interpretation of his recent studies of silica bricks on the opposite view. But Ferguson and Merwin differ from Fenner as to their melting-points: Cristobalite 1,710 deg., tridymite 1,670 deg. C., and they do not explain the criteria on which they rely in their identification of the quartz modifications. Evidence so far does not support the assumption of any definite quartz-transformation temperatures, independent of the rates of temperature and pressure changes; nobody has yet attempted to draw the phase-diagram of quartz, and before that is done all temperature estimates based upon the transformations are premature.

NOTES.

NARROW-GAUGE LINES BEHIND THE BRITISH FRONT.

As is well known, information as to the technical services of our Army have been much more freely imparted to American than to British inquirers, and in recent issues of the *Engineering News Record* Mr. R. K. Tomlin gives some interesting details of the narrow-gauge lines, of which many thousand miles were laid down behind the British front in Flanders and France. These lines were introduced because the roads were proving quite incapable of accommodating the necessary traffic between the main line railheads and the battle zones. The rails used for these lines weigh 10 kg. per metre run and are set to a 60-cm. gauge, the total weight of the track complete being 45 tons per kilometre; steel sleepers were used at the outset, but wood later on. The operation of laying involved in normal conditions an average of about 1,500 man-days per kilometre, but on occasions of urgency 1,100 man-days have sufficed. The lines are practically all single track, thus reducing the width open to the attack of enemy artillery and aviators. On the whole, little damage has been suffered from enemy action, only some 500 m. to 600 m. of track having had in general to be replaced per week. In laying out the line the earthwork was reduced to a minimum, there are thus few embankments, and but little more of trestle work. Grades were limited as much as possible to 1 in 50 or 1 in 40, but there were examples of 1 in 25. Curves were frequent, the minimum radius being 30 m. The trains consisted of 10 to 12 carriages, and as many as 160,000 men have been transported in a day in the zone of a single army, whilst 33,000 tons of stores have been conveyed in a single month in the same zone. In the immediate neighbourhood of the front petrol tractors were used for haulage, as being less conspicuous than steam locomotives, but the latter were used further back. Two patterns of petrol tractor were used, the heavier developing 45 h.p. and weighing 6 tons, whilst the lighter weighed 2 tons and was rated at 20 h.p. The steam locomotives used weighed 14 tons to 17 tons.

ACTION OF LIGHT ON CRYSTALS: PHOTOTROPY.

The term "phototropy" was introduced by W. Marckwald in 1899 to designate certain colour changes observed in crystals, so far only of organic substances, but not in their solution. The phenomena have the general character of a phosphorescence; but we should not like to say which of the two terms, phosphorescence or phototropy, is the wider, and it is doubtful whether or not the phenomena are photochemical or merely physical. The anhydrous chloride of quinquinoline, Marckwald observed, forms crystals of a pale yellow colour; exposed to sunlight, the colour changes in a few minutes into green; placed in the dark the crystals slowly turn yellow again; and this change can be hastened by heating the crystals and by exposing them to the same green radiations which they emitted in the excited condition, or at any rate radiations longer than those used for excitation. There is thus thermotropy as well as phototropy; but most of the substances subsequently examined by H. Stobbe, Padoa, Senier and Shepheard (of Galway College), and others, are not phosphorescent in the ordinary sense, that is to say, they do not display a luminescence in the dark after having been illuminated, nor are they triboluminescent, *i.e.*, they do not glow under friction. But they obey Stokes' law, that the excitation requires radiations of shorter wave-length than the colour called forth.

whilst the reversal is favoured by radiations of that colour. To give another example, certain stilbene derivatives turn red-brown when excited by violet and ultraviolet rays, but reassume their natural yellow colour when exposed to yellow and red rays; the latter change is, according to Stobbe, 1913, hastened by heating the crystals, the former hardly; whether or not the presence of oxygen was essential to the change, could not be decided. Various other observations seemed, however, to favour Stobbe's view that phototropy is confined to compounds capable of existing in several isomeric modifications, and especially to stereoisomerides. This view is not supported by the latest investigation of the problems by F. Weigert (*Zeitschrift für Elektrochemie*, August 1, 1918, pages 222 to 237). Weigert studies the crystals of β-tetrachloro-α-keto-naphthalene in linearly polarised light with special respect to the crystallographic axes. The crystals form four-sided prismatic columns which are capped by truncated pyramids; the crystals are colourless, with a very faint yellowish tint, but turn red-violet when excited by violet or ultraviolet rays, and colourless again when radiated upon by yellow-green light. The observations with a Hilger quartz-spectrograph are difficult because the polarised light used for the observation itself excites the crystals. The absorption spectrum of the crystals varies much with the plane of the polarised light. Defining this plane by the direction of the electric vector which may be in the horizontal plane of the $a\,b$ axis, or be the direction of the vertical c axis (the edge of the prism), Weigert found that the unexcited crystals showed two absorption bands at 395 and 375 $\mu\,\mu$ for the c direction, and an end-absorption at 420 $\mu\,\mu$ in the other case; the excitation did not affect the bands in the c case, but made them much stronger in the $a\,b$ case, when a new band in the yellow-green also appeared; yet the colour change was much stronger in the former case, which is very peculiar. The axial ratio was not altered by the excitation, nor did the X-ray examination of the crystals (after Laue) mark any change, and the solutions of the compounds hardly showed any bands. As the colour changes occur only in the oriented molecules of a crystal, not in the irregularly grouped molecules of solutions, Weigert considers that the phototropic changes are physical and due to intramolecular displacements of atomic groups. But his arguments cannot be summed up in a few words, and he is quite aware that any energy absorption should increase chemical reactivity.

Electric Remelting of Aluminium Pig.—The United States Aluminium Company, of Massena, New York, which is credited with half of the aluminium production of the country, has recently adopted electric furnaces in the place of the oil furnaces (crude petroleum) formerly in use for remelting the pig previous to being cast into ingots or rolling billets. The remelting removes the scum and gives the metal a much brighter colour. The new electric furnaces also serve for the thermal treatment of the aluminium and its alloys. The stationary resistance furnaces (*Chemical and Metallurgical Engineering*, September 1, 1918) are rated at 500 kw. single-phase at 25 cycles. The bowl-shaped hearth can hold up to 4 tons of molten metal; running continuously, the furnace can deal with 1 ton of metal per hour, which is tipped into graphite crucibles. The advantages claimed by H. M. Hall, superintendent of the works, for the electric furnace are: saving in coal and space for power, saving in labour (by comparison with coal furnaces at any rate), cleaner and cooler operation, more uniform mixtures, especially with volatile alloy metals, and a considerable saving in losses of metal.

Tall Chimneys for Metallurgical Plants.—In our article on "Wind Pressure on Tall Chimneys" (Engineering, September 27, page 554 *ante*) the Saganoseki chimney, in Japan, was described as the highest structure of its kind in the world. This is a ferro-concrete chimney. If brick chimneys can compete, the stack which the Tacoma Smelting Company, of Tacoma, Washington, put in operation last March would come in question with its height of 572 ft. 10 in. (against 550 ft.). The shell is built of paving brick on a concrete footing. The outside diameter at the base is 50 ft. 2 in.; the inside diameter of the lining there is 38 ft. 11 in., and the inside diameter of the chimney at the top 23 ft. 11 in.; the brick shell itself ranges in thickness from 5 ft. 1 in. at the base to 13·5 in. at the top; the 4 in. sectional firebrick lining is separated from the shell by 2 in. of air space. Other high chimneys of the Western United States are those of the Anaconda Mining Company, at Anaconda, Montana (525 ft. high, 60 ft. diameter), and at Great Falls, Montana (506 ft. high, 50 ft. diameter). Both these were built by the Alphons Custodis Chimney Construction Company, of perforated radial bricks.

LITERATURE.

Ports and Terminal Facilities. By Roy S. MacElwee, Ph.D., Lecturer in Economics and Foreign Trade, Columbia University. New York: McGraw-Hill Book Company, Incorporated; London: Hill Publishing Company, 1918. [Price 15s. net.]

The title of this book may describe the contents, but the ground covered is wider than is indicated. Not only is the machinery for the collection and distribution of traffic considered in detail and the mechanical and engineering contrivances that facilitate shipment, haulage, &c., described, but the fiscal arrangements that recommend themselves to the Government authorities are brought under review, and opportunity is found to air some aspects of the perennial controversy of free trade *versus* protection. The topic is so extensive that the treatment can hardly be uniform and thorough. Moreover, the exigencies of war, by directing the author's energies into other channels, have curtailed or prevented the discussion of many interesting problems to which, however, a return is promised at a more convenient opportunity. Further, the planning and construction of harbours and ports are matters that have had to be jettisoned and the programme which the author originally contemplated is confined practically to the consideration of the machinery, using the term in a wide sense, that makes for economy and convenience in the handling of goods traffic. Regarded as a general picture of the activities of a port, under the varied conditions of trade and freight, and of the continuous improvements that enterprise, urged by competition, can effect, the account is both graphic and interesting. Sometimes there is a tendency to insist on the obvious, or what is obvious to those who have long been engaged on the problems here considered. But there is always an advantage in studying these problems from many points of view, for every port raises fresh questions that oftentimes can only be solved by experiment.

The ultimate object in view is to stimulate the American nation to the provision of increased port and terminal facilities, in order that the United States may occupy the position of premier maritime power after the war. If the industries, unhealthily stimulated by the war, are not to suffer from collapse, and markets are to be secured that in time of peace will reward the sacrifices made in war, the problem of freight handling becomes of immense importance. Much instructional work has to be done, many erroneous notions have to be weeded out and intelligent combination enlisted between separate corporations, who have hitherto been inclined to regard their interests as self-centred. Dr. MacElwee pleads rightly and wisely for a broader outlook, for the efficient utilisation of all sources that make for progress, urging the advance of the nation's welfare as the consequence and reward of closer co-operation.

The author's qualifications for the task he has undertaken include a long residence in Hamburg, where he has witnessed the growth of the trade of a port of the first order, promoted by the apparently beneficial influence of municipal effort united to individual enterprise. How far the two factors, the growth and the municipal control, are connected as cause and effect it is difficult to say, but we are not prepared to accept the author's conclusions without a much more exhaustive analysis than is here presented. His admiration of the magnitude and progress of the port may warp his judgment. "The port of Hamburg" he tells us, "including the channel to the sea, has been bought and paid for by the people of Hamburg and by no one else. It is a harbour of the people, by the people and for the people and it has cost the people 125,000,000 dols. out of their own pockets." This would imply that ships using the port pay no harbour or tonnage dues, and this is certainly not the author's meaning. On the other hand, if excess profits derived from the use of the harbour facilities have been employed on extensions and improvements, it is scarcely fair to give the whole credit of the port creation to the civic patriotism of the people of Hamburg. As a matter of fact, the Imperial Government contributed about one-third of the total costs of construction, while holding the opinion that since the advantages were mainly local, the remaining funds should be supplied by the local treasury. The author, however, is anxious to extol the advantages of the free port, or "the bonded warehouse zone," recommending the adoption of the general principle as the corner stone of American shipping supremacy after the war, on which may be founded the encouragement of trade and the extension of American commerce.

With the type of traffic that has brought trade and prosperity to inland ports on the Rhine, as Dusseldorf and Duisburg, and with the causes that have contributed to success, Dr. MacElwee is as familiar as with the condition of Hamburg. At such stations the inland water way is seen in its most efficient guise. Its function is quite different from that of the discredited canal in pre-railroad days. Instead of being a competitor against railway traffic, water carriage may be regarded as a coadjutor, particularly useful in safeguarding against congestion and carrying large quantities of goods in bulk at low rates, leaving to the railways freight of a higher specific value, or requiring more rapid transit. The satisfactory commerce at such a port as Mannheim shows that the railroad and the waterway can be made to harmonise and that each can benefit the other. Mannheim by its connection with Baden and Bavaria has a hinterland for local and maritime commerce, fostered by carrying barges of 3,000 tons capacity, importing goods direct from Rotterdam, mainly in bond. Of all the freight entering the city, 5,608,000 tons annually, only 678,000 tons were received from the Prussian Hessian railroad system, 170,000 tons from the Upper Rhine, and 1,293,000 tons by rail from Baden and Bavaria, less than half the total traffic. Mannheim has grown wealthy by reason of waterborne traffic, on railway rates alone she would have stagnated. The growth is entirely due to the fact that raw materials, and particularly bulk materials, from all over the world could be brought into the manufacturing plant of the district by water at small expense. Of course, these statistics refer to pre-war periods, but there can be no doubt but that when we are permitted to see the history of trade movement in Germany in the last five years, we shall find, that stimulated by the congestion of the railroads and the difficulty of procuring coal and rolling-stock, the water-borne traffic has gone up by leaps and bounds. Even without the latest details, the history of the development of navigable rivers should prove particularly instructive, less to ourselves than to America, where the great centres of population are often remote from the sea but can be reached by navigable rivers like the Mississippi and its many tributaries. In England, our long and indented seaboard serves in some measure to replace the great Continental rivers that cannot exist within our limited area. But America, which has brought the traffic on the Great Lakes to so great a degree of perfection, and is fully aware of the advantages offered by New Orleans, has little to learn from German enterprise, and perhaps as little from German municipal competition and policy.

Little is said of English methods, and the remarks are generally disparaging. In comparison with what has been achieved by our successful rivals, the author can only regard our puny efforts with commiseration, as hampered by the inheritance of obsolete inconveniences by which we are hopelessly handicapped in the competition for the world's carrying trade. Manchester is regarded with some favour for the enterprise shown in "building a 35-mile ship canal around Liverpool" and for the organisation of a successful harbour-belt railway by which traffic can be conveyed in railway cars between the various loading and discharging berths at the docks, and at other places on the ship canal, and over different lines to every railway station in Great Britain. Liverpool is regarded as outclassed and stands condemned, because there are no rail connections of importance, a want that compels many of the Liverpool warehouses "to cart every pound of freight to and from their doors." "The attempts at a harbour-belt railway have been failures, because the upland space left for such a system between the docks and the city is so narrow, that only single tracks could be laid if there were any space for tracks at all."

London is considered to possess some good points, but the terminal facilities are not considered adequate for the work or creditable for the greatest consignment port of the world. The methods of lighterage are not so much criticised, as condemned. The lighterage guilds are held to be responsible for opposing improvements that would greatly facilitate the handling of traffic. Far be it from us to defend the action of lightermen, who are especially charged with preventing the introduction of motor tugs or other means of propelling their picturesque craft. The author is justified in saying that with the wider use of motor barges possessing greater carrying capacity and permitting greater economy of operation than the ordinary tide drifting scow, the lighters of London could be made one of the great assets of the port, especially if some improvement were made in the gate locks. Under the present ultra-conservative system, the lighter is in great disrepute, and its bad character exercises an evil influence on the whole lighterage system. A good word is said, however, for the recently erected warehouses and sheds, since they afford an example of the best intensive developments of the necessary linkage between ships, transit shed and railway network.

It is hardly necessary to refer to the description of sheds and warehouses or to the many modern improvements that have been effected in wharves and quays. The account given is adequate and informing. Similarly, the movable machines for shifting cargo, as gantry cranes, travelling belts, electric trucks, telphers, &c., are apparently regarded as terminal facilities, but they are part of general engineering equipment. The warehouse and the transit shed for the temporary storage of goods passing between the ship and the shore are more peculiarly the consequence of port traffic. The sudden arrival of vast quantities of merchandise at irregular intervals, demanding rapid transference from the steamer and protection from weather, makes the provision of temporary accommodation necessary, for however admirable a railway service may be, there must be congestion for longer or shorter periods, for it is an axiom that the volume of traffic a line can carry cannot exceed the capacity of the terminals. Several instances are quoted, which show that the exigencies of traffic, and possibly the alteration of trade routes consequent on the war, have operated in enlarging the provision of warehouse facilities. New Orleans, the most advanced port in America in respect of scientific policy, and perhaps the best situated to acquire increase of tonnage, may be quoted as an example. The new cotton warehouse in course of erection at that port is an evidence of intelligent forecast for future requirements, and an emphatic challenge to competition. It is gratifying to know that the existing warehouses at Manchester have furnished the general plan on which the buildings are being constructed. The warehouses, four of which are now complete, are divided into 124 compartments, each 100 ft. by 30 ft. by 40 ft. The cubical content is sufficient to permit the storage of 1,600 bales of cotton, in four tiers, 10 ft. high. A telpher system of overhead monorail trolleys, with 18 ft. of head room is installed, and elevated tracks and trailers are provided. The compressing room, 200 ft. by 400 ft. in area, allows 10,000 bales of uncompressed cotton to be stored, awaiting treatment. Incidentally, it may be mentioned that the presses installed will enable the bale to be compressed to a density of 33 lb. to the cubic foot, as compared to a former density of 22 lb., reducing the ordinary bale to the dimensions 48 in. by 24 in. by 20 in., implying a saving of 15 per cent. to 20 per cent. in ocean freights. The transit shed, or its equivalent, is 1,513 ft. by 138 ft., built in two storeys having a joint capacity of 75,000 bales of uncompressed cotton. The whole is surrounded by a railroad yard planned to give accommodation to 1,000 cars on 20 miles of track.

If the forecast of the future is instructive by reason of its demand for cautious preparation, courage and initiative, so the study of the character of the machinery that has led to past developments is equally illuminating. The author's historical reviews are informing. The history of grain exportation from America and Canada, as excess of production shifted from the latter to the former, is worthy of study. The States having now little of their own grain for export, have entered into sharp rivalry with Canada for the valuable freight. The author contends that American competition has been successful, and can point to the fact that of the total export of 312,000,000 bushels, 181,000,000 pass through United States ports. But the end is not yet. Canada has alternative routes of shipment from the great collecting ports of Port Arthur and Fort William, where unfortunately there is some rivalry between private interests. In the severity of competition, the fittest route will be selected. New York, handicapped in some respects, is increasing the capacity of the Welland Canal and is modernising the water connection between the Great Lakes and the Hudson River Valley. The struggle is keen and of profound interest, and is important from Dr. MacElwee's point of view, because it illustrates the part that terminal facilities play in the economy of transportation, and the need for anticipating the progress of evolution in all that contributes to rail and water carriage.

The great lesson to be learnt is, that there is no question of railways *versus* waterways, each contributes in its own way to the success of a port, and other factors being equal, that port will obtain the greatest trade that makes the best use of all its facilities.

Telegraphy, Aeronautics and the War. By CHARLES BRIGHT, F.R.S.E., M.Inst.C.E. London: Constable and Co., Limited. [Price 16s. net.]

THIS book appears at an opportune moment. The Empire Press Union has been entertaining journalists from all parts of the Colonies and the Dominions in order to make them better acquainted with the Mother Country, and at the same time to gather their opinions as to the best methods of cementing the union between the United Kingdom and the outlying portions of the Empire. Many suggestions were made by the guests and many complaints were heard. Each particular colony had its own grievance or disability which it desired to see remedied or removed. But all cried out for lower cable rates. It was pointed out again and again that there was no more fertile agent in bringing together the various parts of the Empire than the cheap and speedy communication of news, and particularly of news of the right kind. For instance, the Canadian journalists explained that they were largely dependent upon the messages cabled to the United States papers. These were certainly sent by skilled journalists and were broad and comprehensive, but they were compiled from the American point of view. They were coloured by the prepossessions of the writer, and they were selected to suit the policy of his paper. Matters of special interest to Canadians were often entirely neglected or were reported in such a way as to give a wrong impression. More distant countries, such as Australia, had no near source of home news from which to draw, and therefore were obliged to bear the entire cost themselves, which was a great drain on their resources, and led to many matters of interest being entirely neglected. Of course, there was a substantial lowering of rates to Australia on the completion of the "All-British" Pacific cable in 1902, and although the venture was not immediately remunerative, it has during the war been carrying some 10,000,000 words a year.

Now Mr. Charles Bright, the author of the book before us, has for many years been a strenuous and powerful advocate of cheaper cable rates. He has seized every opportunity to bring the subject before the public, and to secure the ear of business men and statesmen. He has given addresses and papers before the London Chamber of Commerce, the Imperial Mission, and the Royal Society of Arts, and he has also contributed articles on the subject to *The Navy League Annual*, *The Quarterly Review*, *The Nineteenth Century*, *The Empire Review*, *The Saturday Review*, *The Outlook*, and *The Field*. A good deal of this work was like flogging a dead horse, for the cable companies naturally were averse from experiments, while the Government adopted the usual official attitude. Now, however, matters wear a very different aspect. A million or more men from the Colonies have lately been in the country and have seen it for themselves. They have also fought side by side with Englishmen, Scotsmen, Welshmen and Irishmen, and have learned something of the characteristics and diversities of the inhabitants of these small islands. When they return home they will have a far greater and more intelligent interest in the Home Country than they had before, and if this is to be maintained to add to the strength of the Empire lower cable rates will be a necessity.

As the title suggests, this book is by no means confined to an advocacy of lower cable rates. An introduction of 74 pages discusses in great detail the influence of telegraphs, both submarine and wireless, on the operations of war, and contrasts our position in this respect with that of Germany. If there had been no wireless, Germany would have been almost cut off from the rest of the world, except so far as she could prevail on neutrals to act as her intermediaries, as it is well known she did. In anticipation of this condition she had erected a large number of wireless stations, and within a few hours of the declaration of war she was able to warn all her vessels on the distant oceans to seek the shelter of neutral ports. Further, she has always been able, by the aid of wireless, to put her own reports and views before the world, in spite of the fact that Great Britain commands nearly all the cable routes, and can censor every message offered for transmission. This is an example of long-sightedness which should not be wasted upon us when we are considering the question of alternative routes for cables. Fortunately it is not an easy matter to cut cables in the Atlantic and the Pacific, but the attempt would certainly be made if we lost command of the sea for a few weeks. We should then have to depend ourselves on wireless, which would be far from satisfactory, since all messages can be read and codes are by no means secure against interpretation. Mr. Bright advocates the State purchase of all immediately essential Imperial cable and wireless systems, both as a means of national defence, and also to foster the Imperial feeling which has received such an immense extension during the war.

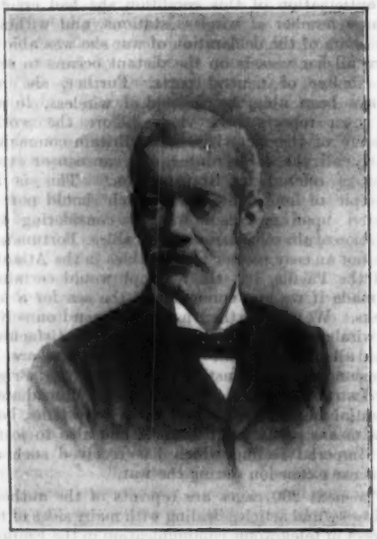
The next 200 pages are reprints of the author's addresses and articles dealing with many sides of the subject of telegraphic communication in the Empire. The interest of the earlier chapters is, of course, largely historical at the present time, showing the efforts that were made to spread a knowledge of the necessities of the Empire before the war had brought them home to all of us. We come into the war time at Chapter IX, which is a reprint of an article which appeared in *The Nineteenth Century* in April, 1915. Then follows a chapter on improved methods of cable working, which is a memorandum supplied to the Dominions Royal Commission. This gives an account of new apparatus of various kinds by which the speed of signalling has, in some instances, been more than doubled. Some of the apparatus are already in extensive use, and others are being tried tentatively. Other memoranda to the same commission deal with various aspects of cable and wireless working from an Imperial aspect.

The last portion of the book is devoted to aeronautical development. Mr. Bright was a member of the Committee on "The Administration and Command of the Royal Flying Corps," and contributed to the report a number of additional recommendations and memoranda which are here printed, and which show by contrast what immense strides we have made in aeronautics since 1816.

It is by no means uncommon for an author to gather up his scattered papers and articles and issue them in book form. This is a procedure that is more directly applicable to matters of literary interest which do not readily grow old. It is somewhat venturesome to apply it to subjects upon which opinion changes rapidly, and had it not been for the war there would have been little justification for the work. But now Imperial considerations are of immense importance, and everything which contributes knowledge to any aspect of them is valuable. Mr. Bright has been connected with submarine cable enterprise in one form or another all his life, and has devoted much time and thought to the subject. In regard to aircraft he stands in a different position and cannot be regarded as an expert.

THE LATE MR. FREDERICK EDWARDS.

Very many of our readers will hear with much regret of the death of Mr. Frederick Edwards. Few engineers were better known among naval architects and shipowners, and indeed among mechanical engineers generally. Mr. Edwards commanded the confidence of his clients by his great engineering ability, and by the rapid insight which always led him to adopt the simplest and most direct measures to attain the end in view. He saw right to the heart of a problem as if by instinct, and brushing aside all complications, attained his ends by very simple means. His air pump affords an example of this. Air pumps had been in use ever since the time of Watt, and had been designed by hundreds of engineers for all kinds of engines, yet that invented by Mr. Edwards marked a great advance on all that preceded it, and this result was attained by a simplification of parts which left men wondering why it had not been effected years ago.

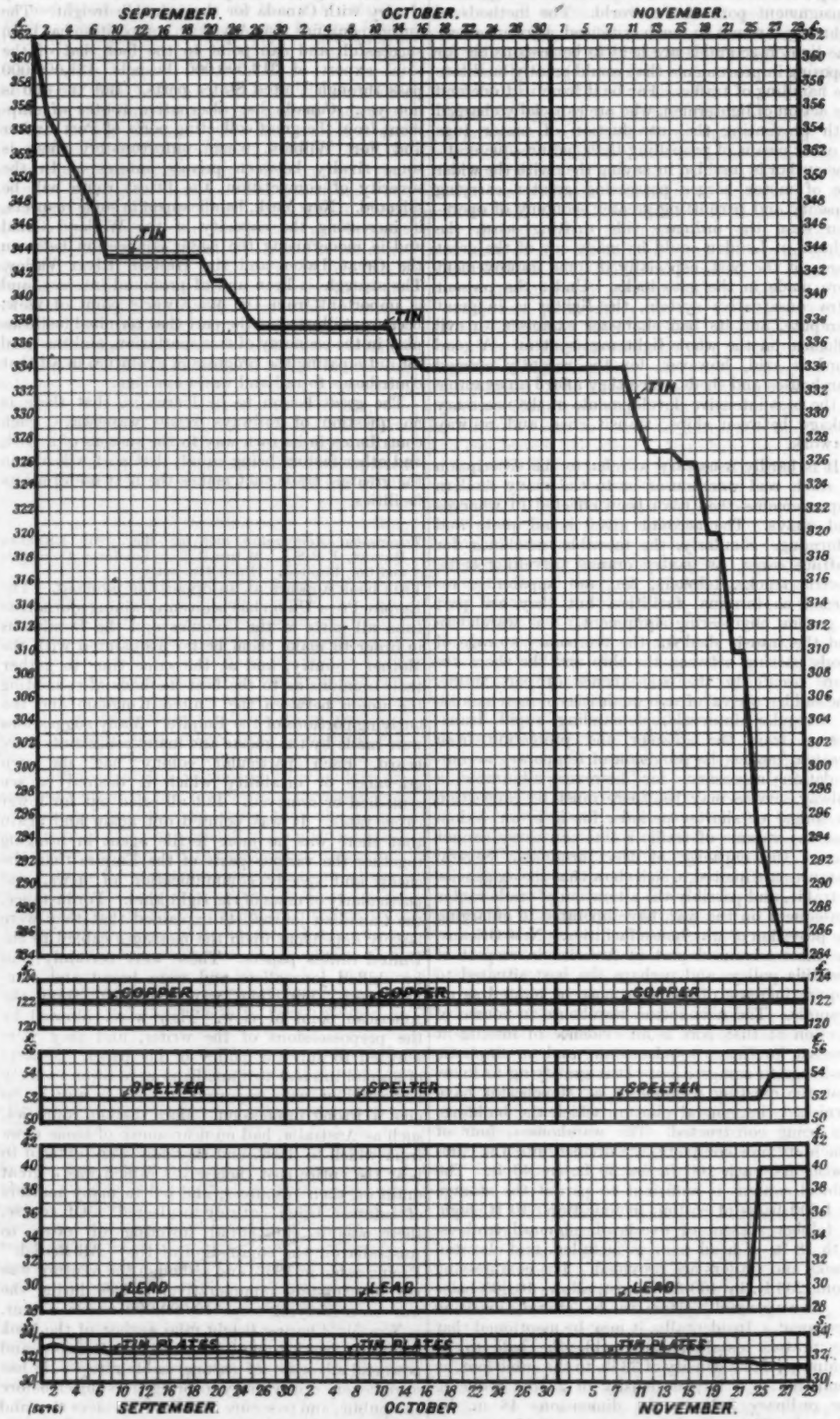


The Late Mr. Frederick Edwards.

Mr. Edwards' death occurred on November 27, at his residence, "Biskra," Bushey Heath, Watford, Herts. Mr. Edwards was a member of the Institution of Civil Engineers, of the Institution of Naval Architects and of the Institution of Mechanical Engineers. He was born on August 3, 1848, and was the son of Henry Edwards, a solicitor. He was educated at Bedford and Enfield, and served an apprenticeship of two years, from 1864 to 1867, with Messrs. Clinton and Owens, hydraulic engineers, Whitefriars, London, E.C., during which time he was engaged for several months in the drawing office, the pattern shop and the fitting shop. He then served a further apprenticeship course of two years, from 1867 to 1870, at the works of Mr. John Stewart, Isle of Dogs, being engaged for over a year in the erecting shops and on board steamers, and for a year in the drawing office. Mr. Edwards then acted as chief engineer, during one year, of the steamship George Reed. He commenced practising as a consulting engineer in 1871, and continued to do so down to the time of his death. Amongst the work carried out by him may be named a slipway and steamers for His Highness Rajah Brooke, of Sarawak; a small fleet of mail steamers for the French Government; and steamers for the Weymouth and Channel Islands Steam Packet Company and Messrs. Gellatly, Hankey and Co. Mr. Edwards served on the Marine Engine Research Committee of the Institution of Mechanical Engineers, and placed two steamers at the disposal of the committee for testing purposes. Among his clients were also Messrs. Wilson and Co., owners of the Gothenburg Line, and the Royal National Mission to Deep Sea Fishermen, for whom he designed hospital steamers. He rendered special services to the British Government, in connection with the midnight photographs taken of the hospital steamer Alpha, which was injured by the Russian Fleet in the Dogger Bank incident—the British Admiralty having put at his disposal a torpedo gunboat and a searchlight; the photographs were used privately at the Paris Commission. Among his later clients were the Associated Portland Cement Manufacturers (1900), Limited, for whom he designed producer plants and gas engines, including a gas plant of 2,400 h.p. and seven Oechelhauser gas engines. Mr. Edwards had of late years made a speciality of oil and gas engines and producers. For some months before his death Mr. Edwards had been in very bad health, and several of his projects had therefore to be abandoned as he had not the strength to prosecute them, although his mental faculties remained acute till the end.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN PRICES OF METALS.

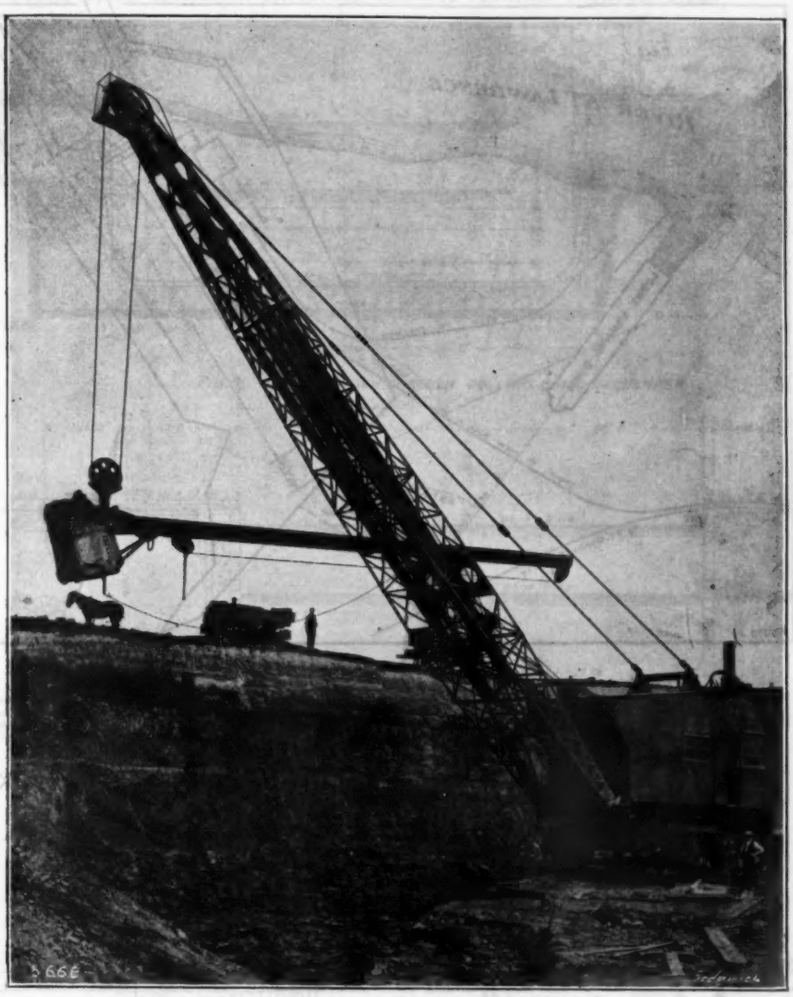
(Specially Compiled from Official Reports of London Metal Markets.)



Note.—In the diagrams above the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange, as far as they have been reported, for "fine foreign" and "standard" metal respectively. The prices shown for lead are for English metal, whilst those for spelter are for American metal. The prices are per ton. The price of tin-plates is per box of I.C. coke free on board at Welsh ports. Each vertical line in the diagram represents a market-day, and the horizontal lines represent 1*l.* each, except in the case of the diagram relating to tin-plates, where they represent 1*s.* each. On July 7, 1916, the Minister of Munitions issued a list of maximum prices and regulations governing the dealing in certain metals, &c.; thus the price of hematite pig iron was fixed at 6*l.* 2*s.* 6*d.*, Scotch at 5*l.* 14*s.*, and Cleveland at 4*l.* 11*s.* 6*d.* per ton. Ship-plates were priced at 11*l.* 10*s.*, and heavy steel rails at 10*l.* 17*s.* 6*d.* per ton. These quotations are still in force. (For official regulations see page 45, vol. cii.)

90-TON STEAM CRANE EXCAVATOR.

CONSTRUCTED BY MESSRS. JOHN H. WILSON AND CO., LIMITED, BIRKENHEAD.



THE steam crane excavator illustrated on this page was constructed by Messrs. John H. Wilson & Co., Ltd., of Dock road, Birkenhead, for Messrs. Walter Scott, Limited. It was designed to excavate and remove a 35 ft. high baring, composed of 25 feet of clay and 10 feet of sand, at a radius of 60 ft., and to discharge at a radius of 80 ft. The digging bucket is of 1¼ cub. yards capacity, fitted with five double flanged wrought iron teeth, steel tipped. The bucket, which is of steel, is fed up to its work by a special steam racking winch, and is arranged to radiate from a fulcrum on the jib. It works at such a speed that it will excavate 400 cubic yards in 10 hours.

The lifting engines have cylinders 8-in. in diameter by 12-in. stroke, while the cylinders of the racking engines are 7-in. by 10-in. The boiler is of the vertical cross-tube type, 5 ft. in diameter by 12-ft. high. The lifting gear has a barrel 26 in. in diameter, and works the bucket by a double rope, 1¼ in. in diameter, of special quality steel. The revolving gear is actuated by double friction cones and the travelling gear by the same means, driving the axles through 2½-in. pitch stud chains. There are eight cast steel double flanged wheels 24 in. in diameter, arranged for a gauge of 14 ft. Four compensating bogies are fitted, one at each corner of the carriage. The wheel base is 14 ft., centre to centre of the compensating bogies.

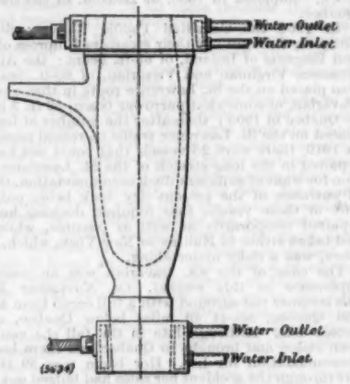
The pillar is 17¾ in. in diameter and the jib is 75 ft. long, centre to centre, and is spread out at the base for attachment to the extreme width of the bottom centre casting. The total weight of the excavator is 90 tons in complete working order.

BRITISH SCIENCE AND INVENTION EXHIBITION.—In view of the wide public interest taken in the British Scientific Products Exhibition, held at King's College, London, during the past summer, the British Science Guild has decided to organise another exhibition next year. The main object of the exhibition will be to stimulate national enterprise by a display of the year's progress in British science, invention and industry. Further particulars of the exhibition will be available in due course. A large part of the recent exhibition has been transferred to Manchester where it will be on view at the Municipal College of Technology towards the end of this month.

THE JUNIOR INSTITUTION OF ENGINEERS.—Owing to the cessation of hostilities and the consequent demobilisation of a large number of men who have served their country in the forces and in munition factories, it is expected that many of the members of the Junior Institution of Engineers will be available for the filling of vacancies in the technical and administrative departments of engineering firms. The bringing together of suitably qualified men and appropriate vacancies is a subject which has always engaged the attention of this society, and for many years past has been one of the features of its activities. In this capacity of intermediary the Institution holds an unique position in being able to draw upon all sections of the engineering profession, the membership not being restricted to any one class. At a time like the present when the engineering activities of the country are undergoing far-reaching alterations with the consequent changing over of a large number of technically-trained men, it will undoubtedly be of value to both employers and employees to know of this feature of the Institution's work. The secretary (39, Victoria Street, Westminster) will be glad to aid any of our readers who may be in want of technically-trained assistants and who will communicate with him.

ELECTRICALLY-HEATED GRAPHITE CRUCIBLES OF THE MORGAN CRUCIBLE COMPANY.

IN our article on the "New British and Key Industries Exhibition," on page 439, *ante*, we noticed the electrically-heated crucibles of the Morgan Crucible Company, Limited, of Battersea Works, S.W. 1. We



are now able to add a diagram explaining the construction of one of these crucibles. The figure on this page shows the vase-shaped crucible which is provided with a lip and with extension pieces for mounting the annular electrodes which are water-cooled; the crucible itself serves both as resistor and as container for the metal or other substance to be heated or fused.

AGRICULTURAL MACHINERY FOR ROUMANIA.—Before the war Austria-Hungary supplied Roumania with 40 per cent. of her requirements in agricultural machines. This supply has ceased since 1914. Roumania had a good stock of agricultural machines, sufficient to last her up to the present time; only various spare parts for special machines had to be furnished. The supply of machines is now giving out. Roumania consequently offers an excellent market for agricultural implements, especially for tractors and fodder cutters, which are little known in that country.

LAUNCH OF FERRO-CONCRETE VESSEL.—On the 19th ult. there was launched at Faversham, at Messrs. James Pollock, Sons and Co., Limited's, new shipyard at Upper Brents, the Molliette. The dimensions are: Length overall, 131 ft.; breadth moulded, 25 ft.; depth moulded, 11 ft. 9 in.; draught loaded, 9 ft. 9 in. The vessel is designed to carry 320 tons of cargo. It is fitted as a three-masted fore-and-aft schooner. The main propelling machinery consists of the latest type Bolinder crude oil engine of 120 brake horse-power, sufficient to give the vessel a speed of 7 knots in calm weather, without the use of the sails. We understand the builders will grant permits for inspection, if application in writing is made to them.

THE DE WENDEL INDUSTRIAL CONCERNS.—Just prior to the signing of the armistice by Germany the German Imperial Industrial Board gave orders to stop the liquidation of the large de Wendel mines, iron and steel works in Lorraine. The liquidation was already, in the beginning of September, so far advanced that the so-called Raumer groups bid for the A lot, comprising the iron and steel works and some mines, and a bid from a number of works within the Steel Union for the B lot, comprising the rest of the mines, had been accepted. Some formal business still had to be settled, and in the meantime the Raumer group had shown a disinclination to complete the deal; the Steel Union works, on the other hand, had arranged a meeting in order finally to clinch their purchase, when an order came from the Imperial Department in question that the liquidation was not to be proceeded with.

IRON ORE AND IRON IN SWEDEN.—According to official statistics now made available, and although production in several cases is smaller than during the preceding year, the financial result of the Swedish iron industry on the whole is satisfactory on account of the higher prices realised. The production of iron ore amounted to an aggregate of 6,217,172 tons against 6,986,298 tons for the previous year, but the value rose from about 69,000,000 kronor in 1916 to about 84,000,000 kronor in 1917. The production of pig-iron showed an increase, the total for last year being 828,969 tons, against 732,734 tons for 1916. The value of the pig-iron made rose even more than the production, the price having been nearly doubled in the course of the year; the aggregate value for 1917 was 233,800,000 kronor, against 114,700,000 kronor for the preceding year. The production of bar iron and steel receded some 29,000 tons, band, nail and other fine iron about 1,400 tons, and solid tube material by some 8,700 tons. The total aggregate value of the production of the Swedish iron and steel work during 1917 is put at 381,700,000 kronor, against 243,000,000 kronor for the preceding year.

CHAMPLAIN DRY DOCK FOR QUEBEC HARBOUR.*

By U. Valiquet, M.Can.Soc.C.E., Superintending Engineer, Department of Public Works.

For a number of years the River St. Lawrence has been frequented by ocean steamers of such dimensions that they could not be accommodated in the Lorne Dry Dock, completed in 1886, at Lauzon, in the harbour of Quebec.

In 1906 the Canadian Pacific Railway Steamship Company brought out their steamers Empress of Britain and Empress of Ireland, of 65-ft. beam; the Allan Line steamers Virginian and Victorian, of 60-ft. beam, were also placed on the St. Lawrence route in that year. The Bavarian, of somewhat narrower beam, 59 ft. 3 in., came to Quebec in 1905; thereafter the number of large ships placed on the St. Lawrence traffic increased rapidly until in 1912, there were 25 vessels that could not have been repaired in the long stretch of the St. Lawrence navigation for want of sufficient dock accommodation, the width of entrance of the present dry dock being only 62 ft. Any of these vessels that required docking had to be repaired temporarily as well as possible, while afloat, and taken either to Halifax or New York, which, in some cases, was a risky undertaking.

The case of the s.s. Bavarian was an unfortunate experience in this respect. On November 5, 1905, this steamer ran aground with a full cargo from Montreal and Quebec, about 40 miles below Quebec, opposite Grosse Isle. Although late in the fall she could have been raised and brought to Quebec had there been dock accommodation for her. Her beam was 59 ft. 3 in., but through the accident her sides had bulged out beyond the width of the dry dock entrance. She was raised in the following spring, although further damaged by ice during the winter, and brought on the beach a short distance below the dry dock, where she was sold as scrap. This is the worst case on record in the history of the St. Lawrence navigation. This vessel was only six years old and of a registered tonnage of 10,387 tons.

In the summer of 1898 the writer was instructed to prepare a report on the practicability of widening the entrance of the Lorne Dry Dock, which had been completed in 1886. A plan was submitted, showing the possibility of obtaining an entrance 70 ft. wide, by removing part of the timber slides at the outer end of the dock; increasing the length was also suggested. The first was reported to be inadvisable as it would greatly disfigure the dock and do away with the convenience of the timber slides; the only feasible way would be to remove and rebuild in another position the eastern side wall, thus depriving the harbour of all dock accommodation for probably two seasons. A new caisson would necessarily have to be provided; the cost would have been considerable. Further, it was considered that a new dry dock would be required in Quebec before many years.

The suggestion of lengthening the dock was adopted; the length was increased from 484 ft. to 600 ft.; this consisted merely in moving the circular head, stairways and timber slides 116 ft. further, after excavating the rock to proper width and depth. The work was performed under contract awarded in the year 1900, for the sum of 100,000 dols., and completed in 1901 without interfering with the use of the dock. The details of construction of this dry dock have already been described in a paper read before the Canadian Society of Civil Engineers some years ago, by Mr. St. George Boswell, chief engineer of the Quebec Harbour Commission, who was assistant engineer during the construction. This dry dock was built by the Quebec Harbour Commissioners under an Act, 38 Vict. Cap. 56, 1875, by which the issue of bonds was allowed to obtain the necessary amount. The work was started in 1878 and completed in 1886 at a total cost of 921,130 dols.

In 1888 the Canadian Government relieved the Harbour Commission of all obligations to refund the principal sum or interest expended on the dry dock, and in 1890 it was placed under the control of the Department of Public Works; the writer was then placed in charge.

In 1906 the Quebec Board of Commissioners urged upon the Government the necessity for a large dry dock for the harbour of Quebec. In the fall of the same year the writer was instructed to make a survey of the locality surrounding the old dry dock and report on the best location. Two sites were examined, but the position to the east of the present dock was considered the most advantageous for three principal reasons, viz.: A larger area of land could be acquired; a better foundation could be obtained; the repairing plant of Messrs. G. T. Davie and Sons could have better access to both the new and old docks.

A plan and report were submitted in the early part of 1907; the dock then proposed was 1,000 ft. long with an entrance width of 100 ft. The proposition was not immediately acted upon; the question as to whether the Government should build the dock, or induce some shipbuilding firm to build it under a subsidy from the Government, was unsettled. The result of the discussion was the passing of an Act of Parliament at the session of the year 1910, assented to on May 4, called an Act to Encourage the Construction of Dry Docks. Under this Act the dry docks were divided into three classes. The first-class included dry docks estimated to cost not more than 4,000,000 dols., and capable of receiving and repairing the largest ships of the British Navy and of the following dimensions:—

(a) Clear length on bottom 900 ft.; clear width of entrance 100 ft., with depth on sill at high water ordinary spring tides of 35 ft.

* Paper read before the Canadian Society of Civil Engineers.

CHAMPLAIN DRY DOCK FOR QUEBEC HARBOUR.

MR. EUGENE D. LAFLEUR, ENGINEER.

Fig.1.

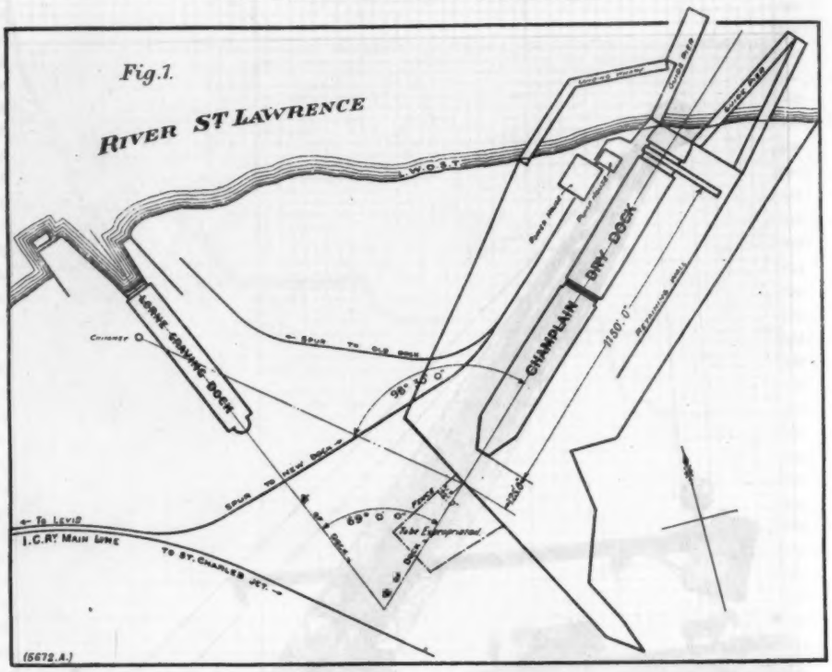


Fig.2. PLAN.

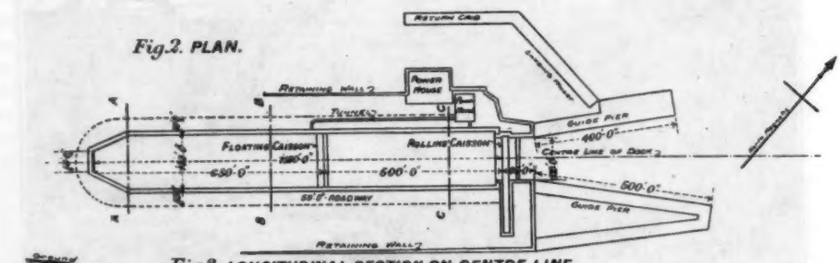


Fig.3. LONGITUDINAL SECTION ON CENTRE LINE.

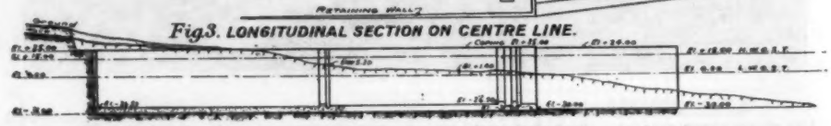


Fig.4. TYPICAL SECTIONS OF DOCK SHOWING EXCAVATIONS.

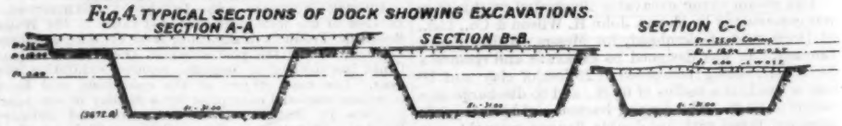


Fig.5. PART LONGITUDINAL SECTION SHOWING ENTRANCE. (WEST SIDE).

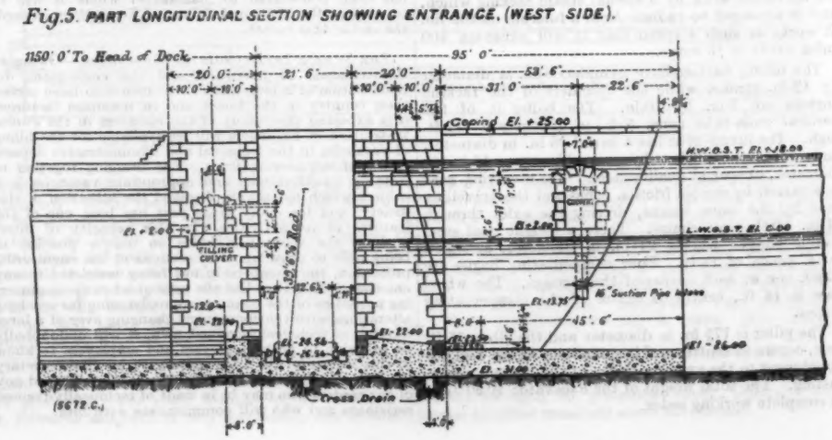


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Fig. 6. CROSS SECTION AT ENTRANCE SHOWING FLOATING CAISSON SILL.

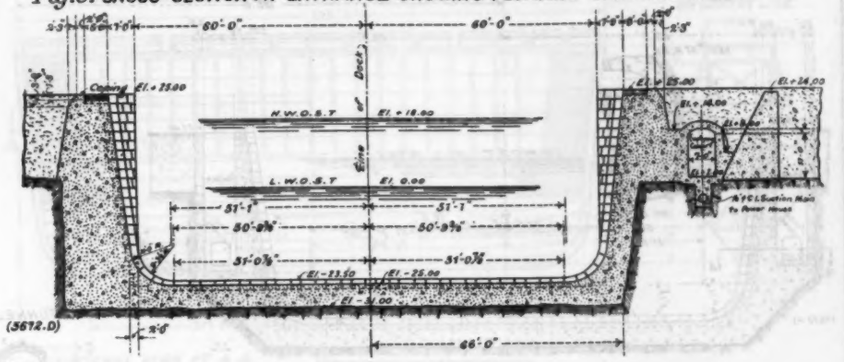


Fig. 7. CROSS SECTION THROUGH ROLLING CAISSON CHAMBER

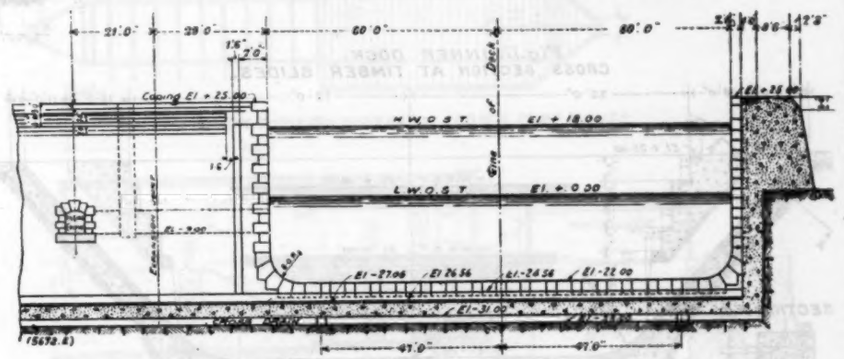


Fig. 8. CROSS SECTION LOOKING NORTH, SHOWING ROLLING CAISSON SILL

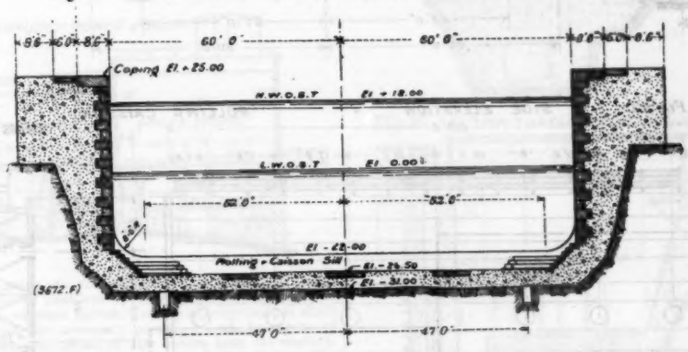
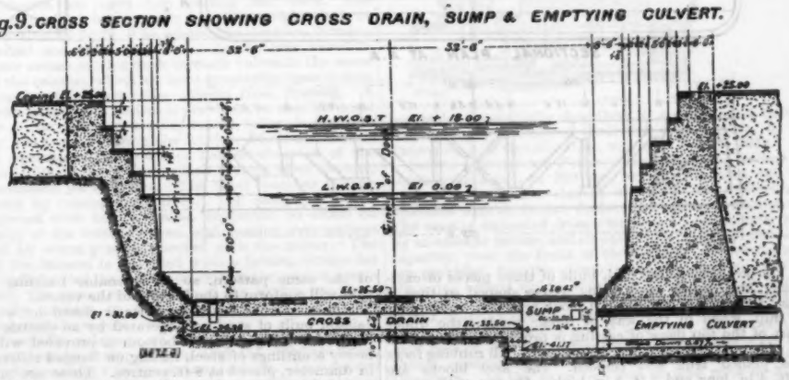


Fig. 9. CROSS SECTION SHOWING CROSS DRAIN, SUMP & EMPTYING CULVERT.



(*b*) Floating dry docks of a lifting capacity of 25,000 tons.

The second class included dry docks estimated to cost 2,500,000 dols. of the following dimensions :—

(*a*) Clear length on bottom, 650 ft.; clear width of entrance, 85 ft.; depth of water on sill at ordinary high water spring tides 30 ft., if in tidal waters, or 28 ft. on sill, if constructed in non-tidal waters.

(*b*) Floating dry docks of a lifting capacity of 15,000 tons.

The third class consisted of dry docks estimated to cost not more than 1,500,000 dols., of the following dimensions :—

(*a*) Clear length on bottom, 400 ft.; clear width of entrance, 65 ft.; depth of water on sill at ordinary high water spring tides, 22 ft., if in tidal waters, and 18 ft. if in non-tidal waters.

(*b*) Floating dry docks of a lifting capacity of 3,500 tons.

The estimated cost in all cases includes the totally equipped repairing plant capable of effecting all sorts of repairs, including machine shops and tools, foundry, administration buildings, &c., together with the dock itself, but does not include marine slips or other installation used in the construction of ships.

According to the Act, the subsidy on dry docks of the first class is 3½ per cent. per annum on the estimated cost for a period of thirty-five years from the time it has been reported that the dry dock is entirely completed. The subsidy on the second class is 3½ per cent. per annum for twenty-five years from the time of completion. On the third class, the subsidy is 3 per cent. for a period not exceeding twenty years from the time of completion. In all cases the company making the application must furnish plans with a detailed list of the plant and a complete estimate of the cost. These are revised and corrected, if found advisable; and, upon a report from the chief engineer of the Department of Public Works that the works intended to be built are in the public interest, the application is granted upon certain conditions of management and maintenance. The works are to be executed under the superintendence of an officer of the department.

The above Act was amended in April, 1912, by making the length of the first-class dry docks 1,150 ft., the entrance 110 ft. and the estimated cost 5,500,000 dols. Another amendment was made in May, 1914, by which the subsidy of 4 per cent. on the estimated cost is allowed for first-class dry docks. The Act was further amended in 1917, by which the dimensions of the first-class dry docks shall be: Length on bottom, 1,150 ft.; width of entrance, 125 ft.; depth on sill at high water spring tides, 38 ft. A subsidy of 4½ per cent. on the estimated cost of 5,500,000 dols. is allowed, payable half-yearly for a period of thirty-five years from the time of completion. By this amendment no bonds or debentures are to be issued until 1,000,000 dols. shall have been expended on the construction of the dry dock.

After the passing of the Act of 1910, shipbuilding firms were invited to build a dry dock at Lauzon, in the Harbour of Quebec, under the subsidy Act of that year. Two companies submitted plans and offered to build under contract without reference to the subsidy Act. In 1912 another company submitted plans for a dry dock to be built on the Quebec side of the harbour, just below the mouth of the St. Charles River, according to the subsidy Act, as amended in 1912. Some objection having been made to this location and with no prospect in view for any other applicant, the Department of Public Works decided that a dry dock would be built by the Government.

The New Dock.—In the early part of 1913 the writer was instructed to prepare plans and specifications on which tenders could be called as soon as possible for the construction of the new dry dock, the location being to the eastward of the Davie Shipbuilding Yard, so that both the old and new dry docks would be easily accessible from the shops. Tenders for the construction of this work were advertised on May 12, 1913, to be received on June 30 following. The contract was awarded to the lowest tenderers, Messrs. M. P. and J. T. Davis. The contract was signed on October 7, 1913.

The new dock was at first intended to be built on a line parallel to the old dry dock, but this was objected to from the point of view of navigation. A Commission was appointed in the fall of 1913 to investigate and find out which direction would best suit the entrance facilities, and it was decided that the centre line of the dock should form an angle of 69 deg. with the direction of the old dry dock, or approximately 45 deg. N.E., and it was so laid out. (Fig. 1, page 658).

Owing to the limited time available before the calling of tenders, general plans only were prepared, together with an estimate of the cost. The requirements as to details for the machinery and caissons were stated in the specification; the contractors were requested to furnish during construction all detail plans, to be submitted for approval by the department.

The dry dock has the following general dimensions, Total length from outer caisson to head wall 1,150 ft., divided into two compartments. Outer part 500 ft.; inner part 650 ft. (Figs. 2 to 4, page 658).

	Ft.
Width of entrance	120
Width at coping	144
Width on floor	105
Depth on sill at high water spring tides	40
Depth on sill at low water spring tides	22
Spring tides rise	18
Coping of side wall above high water spring tides	7
Floor at outer end below outer sill ...	4½
Slope of floor transversely	1 in 100
Western guide pier	400
Eastern guide pier	500
Depth in entrance channel at low tide	30

The land expropriated in connection with the construction of the dry dock has a superficial area of 25½ acres, of which 11½ acres are reclaimed beach land. The outer entrance of the dock is closed with a rolling caisson, the top of which is provided with an automatic folding bridge; a floating caisson (Fig. 6) closes the inner entrance. This caisson can also be placed to close the

outer entrance in cases when repairs are required to be made to the rolling caisson (Figs. 7 and 8).

Three main centrifugal pumps each of 63,000 gallons per minute capacity are used to empty the dock; two pumps of 6,000 gallons per minute each are used to keep the dock dry. All pumps are run by electric power. Eight boilers of a total capacity of 3,600 h.p. furnish the steam at 200 lb. pressure to run the three direct-current turbo generators of 1,500 kw., 750 kw. and 300 kw. respectively, which furnish the current at 550 volts to run the pump and other motors.

A direct-current generator of 200 kw. at 220 volts, driven by a steam engine, will furnish the current for the lamps around the dock and in the buildings. There are 24 lamps of 500 watts, hung from poles around the dock. The poles are made of gas pipe, with the lower end set into sockets fitted with electric connections, and made removable in case of necessity. All electric wiring for lamps and motors outside of the buildings is placed underground.

The approximate quantities of the material in the principal items entering into the construction are:—

Rock excavation above and below coping	342,000 cub. yd.
Submarine rock excavation in channel	65,000 cub. yd.
Dredging entrance channel ...	530,000 cub. yd.
Concrete	100,000 cub. yd.
Granite steps, altars and quoins	140,000 cub. ft.
Steel beams, reinforcing bars and manhole covers	150,000 lb.
Cast-iron for roller casings and sluice valves	125 tons.
Cast steel for caisson rollers ...	65 tons
Gun-metal for caisson roller and valves	4,500 lb.
Cast-iron in keel blocks and bollards	990 tons
Forged steel spindles for rollers	11,000 lb.
Bricks for chimney and flues ...	345,000
Fire-bricks	125,000
Cribwork in approach piers ...	63,300 cub. yd.
Concrete in approach piers ...	13,300 cub. yd.
Steel in rolling caisson ...	930 tons.
Total weight in rolling caisson and machinery	1,125 tons
Steel in floating caisson ...	960 tons

The work was started in May, 1914. The concrete retaining walls on each side of the dock, specified to be built from the natural rock surface to elevation + 24 and intended to prevent seepage through the filling, were completed during the season's work, as well as the cofferdam between the outer ends of these walls. Rock drilling in the prism of the dock was also carried on in the part not affected by tides. The largest part of the drilling was done by two well drillers, the holes being sunk down to grade and plugged for future blasting. The average depth of perforation for each drill was about 80 ft. per day, although as much as 130 ft. was done occasionally. Ten or 12 ordinary steam drills were also used on the work.

The rock consisted of hard shale, irregularly stratified, at an angle of about 45 deg. Considerable rock slides occurred on the west side of the cut, which necessitated a much larger quantity of concrete for the dock wall on that side, also the use of rock bolts, to prevent the sliding tendency of this wall. Steam shovels and dump cars were used to remove the blasted rock, which was used for filling, wherever required, on the Government property.

The cofferdam was built of timber cribwork, 20 ft. wide, sunk in an average depth of 1 ft. of water, at low tide and built to the elevation of 3 ft. above high tide; a layer of concrete was deposited along the bottom of the outer face and this face was sheathed with plank.

The floor and walls of the dock are built of concrete, the mixture being 1–3–5. All exposed faces are finished with a fine concrete of 1–2–4 mixture for a thickness of 6 in. The concrete for the walls and the floor was cast in alternate sections of approximately 30 ft., with expansion joints. All the cement used was subjected to a laboratory test; apart from other requirements the tensile strength was required to be 600 lb. per square inch after 27 days' immersion, for neat briquettes, and 275 lb. per square inch for 1–3 mixture.

The steps at the top of the walls are built of granite, with treads and risers of 12 in.; the altars are 2 ft. 6 in. wide and consist of granite 12 in. thick tailing 9 in. into the concrete (Fig. 9. The caisson stops of both entrances and all culvert openings are built of granite. The floor is 5 ft. thick (Fig. 6) and finished level from end to end; the sides slope down 6 in. to the side gutters. The floor is provided with three strips of granite slabs, 18 in. thick, intended to receive the cast-iron keel and bilge blocks. The middle strip is 10 ft. wide and level; the side strips are 9 ft. wide (Fig. 9).

In order to prevent the possibility of hydrostatic pressure under the floor and behind the side walls, a system of drains is provided, that will take the seepage water to the sumps.

There are 12 stairways from the top of the walls to the floor of the dock, two at each end of the two compartments and two half-way between the ends of each compartment. Four timber slides, built of granite slabs, 18 in. thick, are provided alongside the last set of stairways (Fig. 11). There are also eight ladders, four on each side of the dock, that may be used to reach the floor. These are built with galvanised iron gas pipe, and set in recesses in the walls.

The coping of the walls stands at elevation + 25, or 7 ft. above high tide. They are provided with the ordinary cast-iron bollards, set in concrete blocks, 60 ft. apart. There are nine electrically-driven capstans with 15-h.p. motors, four on each side of the dock and one at the head.

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Fig. 10. CROSS SECTION THROUGH INNER FLOATING CAISSON BERTH

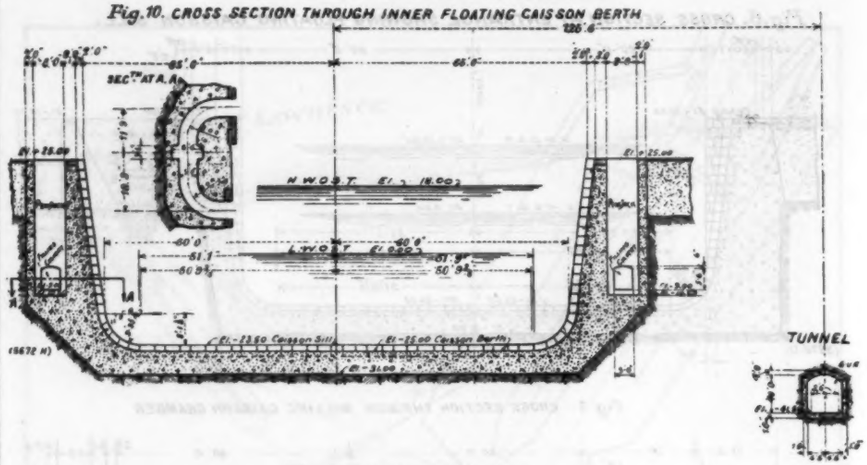


Fig. 11. INNER DOCK. CROSS SECTION AT TIMBER SLIDES.

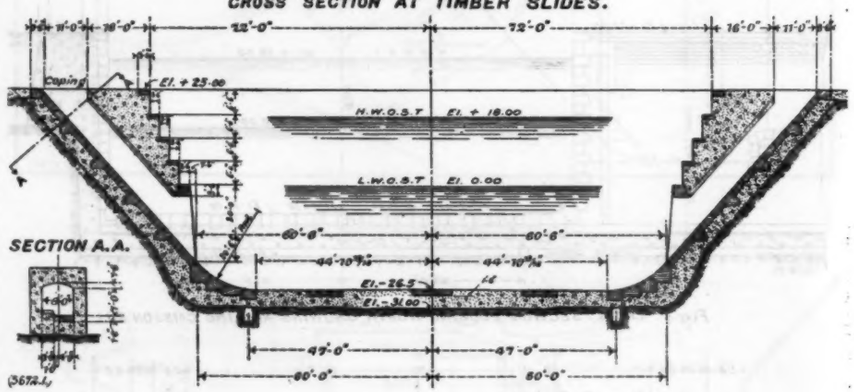
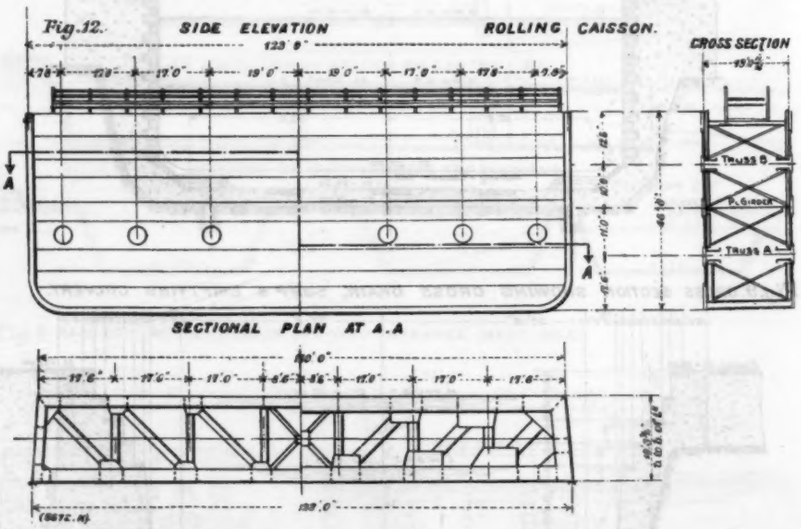


Fig. 12. SIDE ELEVATION ROLLING CAISSON. CROSS SECTION



The keel blocks are each built of three pieces of castings; the middle piece being wedge shaped so that it may be knocked out and the block removed from under a ship, when in the way of repair work; the upper part of the top piece of casting is provided with a piece of white oak tenoned into the casting. All rubbing faces are planed true and smooth. The keel blocks are 4 ft. 4 in. long and 2 ft. 3 in. high. On top of these are placed temporary hard wood timber blocks to obtain the required height above the floor. It had been intended to build bilge blocks, so arranged as to slide under the bilge of vessels. However, this was objected to by the British Admiralty, who insist on having all blocks made of the same pattern, so as to enable building a bed that will conform to the bottom of the vessel.

Caissons.—The outer entrance is closed by a rolling caisson built of steel and operated by an electric motor of 125 h.p. (Fig. 12); the bottom is provided with two heavy scantlings of steel, resting on flanged rollers, 3 ft. in diameter, placed at 8-ft. centres. These are made of cast steel and bored to receive bronze bushings. The forged steel spindles, 4 in. in diameter, are also provided with bronze sleeves. The cast-iron casings, containing the rollers, are set in the concrete altars, on each side of the caisson berth and chamber. At an elevation of 15 ft. 9 in. above the sill of the dock the rolling caisson

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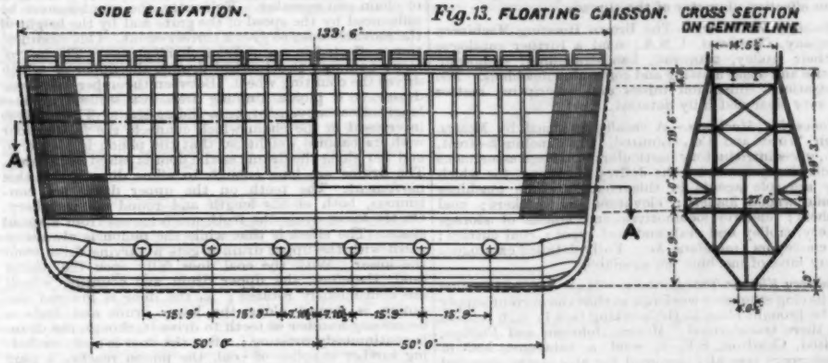
SIDE ELEVATION.

Fig. 13. FLOATING CAISSON.

CROSS SECTION ON CENTRE LINE.



SECTIONAL PLAN AT A.A.

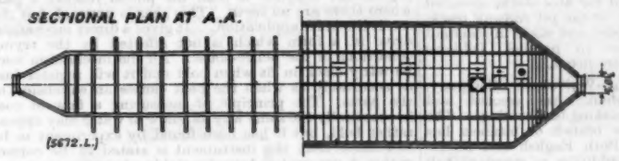
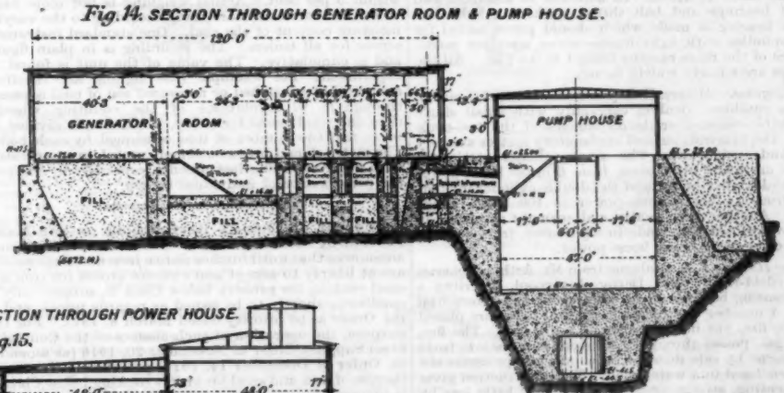


Fig. 14. SECTION THROUGH GENERATOR ROOM & PUMP HOUSE.



SECTION THROUGH POWER HOUSE.

Fig. 15.

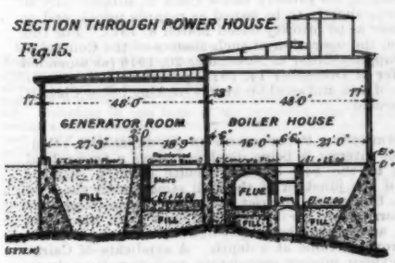
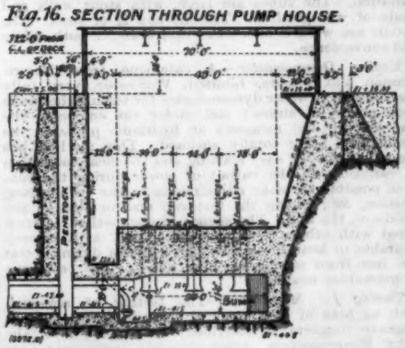


Fig. 16. SECTION THROUGH PUMP HOUSE.



is provided with six culverts, 42 in. in diameter, closed by sluice valves that are operated from the upper deck by a 15-h.p. electric motor, driving a longitudinal shaft provided with the necessary gearing; and, by means of clutches, any one or all of the valves may be worked. The culverts are used for flooding the dock. The caisson is divided horizontally by a watertight deck at the elevation of 23 ft. 6 in. above the bottom, forming the ballast and tidal chambers. As the tide rises the sea water comes on this deck through valves in the outer face of the caisson, which are kept constantly open during the summer to prevent the caisson from floating. A sufficient quantity of ballast is provided, so that the total weight of the structure resting on the rollers is approximately 150 tons. During the winter, when the dock is not in operation, the lower or ballast chamber of the caisson is filled with water, which is kept from freezing by a constant jet of steam. The tidal chamber is then kept dry by closing the valves. The caisson is closed and opened with heavy chains, supported on altars on each side of the caisson recess, and passing over pulleys worked by worm gears connected with the motor. The top of the caisson is provided with a folding bridge for light traffic across the dock; as soon as the caisson starts to open, the apron and railings of the bridge are automatically lowered to allow them to pass under the flooring over the caisson recess.

The middle entrance of the dock is closed by an ordinary floating or ship caisson. (Fig. 13). When in place, the deck is used as a bridge across the dock. This caisson may also be used to close the outer entrance by placing it immediately outside the rolling caisson, where the necessary stop is provided for it. This, however, will be necessary only in cases of repairs being required for the submerged parts of the rolling caisson. These caissons were built by the Dominion Bridge Company, under a sub-contract. The mode of construction and other particulars were fully described in a paper read before the Canadian Society of Civil Engineers by Mr. L. R. Thomson, A.M.Can.Soc.C.E., vol. xxx, Part 1, 1916.

Boilers and Electric Power.—Six water-tube boilers of 500 h.p. and two of 300 h.p. furnish steam at 200 lb. pressure to produce electric current. The boilers are provided with automatic stokers, ash and coal conveyors. The coal is unloaded from cars into a coal crusher run by an electric motor, and elevated to a hopper of 500 tons capacity, over the front of the boilers. Water heaters are provided, but the steam is not superheated; one of the small boilers will be constantly under pressure to run the drainage pumps and the lighting dynamo. (Fig. 14).

The electric power consists of three direct-current turbo generators of 550 volts, one of 1,500 kw., one of 750 kw. and one of 300 kw. The steam turbines are of the Curtis condensing type, built by the General Electric Company. In the large unit the turbine runs at 3,600 r.p.m. It is geared down to 360 revolutions for the generator; the second is geared from 5,000 r.p.m. to 750 r.p.m., the third is geared from 5,000 r.p.m. to 900 r.p.m. A 100-kw. generator driven by a high-speed direct connected steam engine, furnishes the current for lighting purposes.

This power installation is more than ample for all the machinery connected with running of the dock proper. It is, however, anticipated that the whole of it will be used when large repairing and shipbuilding shops are in operation together with the pumping of the dock.

This electric installation has been criticised on the ground that the large expenditure is not justified when electric current is available from private companies in the vicinity of Quebec. When the electric installation was proposed by the writer the idea in view was that no company would be interested or willing to furnish over 3,000 h.p. at any time of the day or night for the short period of 50 hours in the year without interfering seriously with their general service. It had also been ascertained by personal visits to five of the principal navy yards of the United States Government that each of them has provided its own electric power for pumping their dry docks. Out of five, only one had installed alternating current machinery. It has developed since that the only electric company that could furnish the power current is not willing to entertain the proposition unless at a much greater cost to the Government than the private installation can be run, including the interest on the outlay, which is approximately 240,000 dols.

Pumps.—The dock is emptied by three main pumps of the horizontal centrifugal type, each having a capacity of 63,000 gallons per minute. The bronze shafts are connected to the armature shafts of 800-h.p. motors, running at 750 r.p.m. The motors are built to stand an overload of 25 per cent. for 2 hours; the total lift will very rarely be more than 33 ft. The suction and discharge pipes are 48 in.; the water is discharged into a chamber provided with non-return valves, and to a culvert through the entrance wall outside of the caisson. The main pumps are guaranteed by the builders to deliver 63,000 gallons per minute against a total head of 25 ft. At the time of writing these pumps have not been tested as to efficiency.

Two auxiliary pumps, each of 6,000 gallons per minute capacity, driven by electric motors of 125 h.p., will take care of leakages and seepage; these pumps will also help while the dock is being pumped. The pumps were manufactured by the Allis-Chalmers Company. The time occupied in emptying the dock will vary according to the height of tide when the pumps are started and the size of the vessel being docked. At high water of spring tides the dock contains over 38,000,000 gallons of water. This quantity of water, however, will very rarely, if ever, exist, when pumping is started. It is estimated that the average time for pumping out the dock will be about 2½ hours.

Underground culverts, 9 ft. by 10 ft., (Fig. 9) convey water from the sumps in each compartment of the dock to the pumps; these culverts are provided with sluice gates, so as to permit of operating each compartment separately. The gates are operated from coping level by 15-h.p. electric motors. The pressure against the gates may at times be due to a head of 50 ft. of water.

From the non-return valve chamber the discharge culvert is 7 ft. by 12 ft.; it is also provided with a sluice gate. The capacity of discharge of this culvert was obtained from Chezy's formula $V = c\sqrt{rs}$, being obtained from Kutter's formula. Under a head of 4 in. the capacity will be ample to take care of the output of the pumps when discharging in open air.

The dock is filled through the six culverts in the outer caisson (Fig. 12), each having an area of 9 sq. ft., also two culverts, one in each side wall of a sectional area of 30 ft., the valves of which are operated by electric power. These culverts are made exceptionally large due to the fact that each may only be partially opened until the water in the dock has reached the centre of the culvert opening, to prevent the heavy current that would result from a large opening from disturbing the beds prepared to receive a vessel; further, as the head between the outer and inner levels of water decreases, the valves are fully opened, thus obtaining a large flow. The time required to fill the dock may at times be as much as 4 hours. The middle entrance is similarly provided with filling culverts as the outer entrance. (Fig. 13).

In order to obtain sea water by gravity for the purpose of washing the floor of the dock, 6-in. pipes were laid in the concrete side walls of the dock, at an elevation of 2 ft. above low tide; each pipe has six hose connections and valves at the face of the walls, where 50-ft. lengths of 2½-in. hose may be attached for the purpose. The water is available within 1 hour of extreme low tide. Washing the floor is necessary owing to the sediment accumulated while the dock is flooded.

Guide Piers.—The Western guide pier is 400 ft. long and 75 ft. wide; that on the east side is 500 ft. long, 75 ft. wide at the outer and 200 ft. wide at the inner end (Fig. 1). Each is built of two lines of 12 in. by 12 in. timber cribwork substructure up to 6 ft. above low water, spring tides; the outer face of each line of cribwork is built close, and sheathed vertically with 10-in. hardwood planks. The cribs facing on the channel were sunk in a depth of 30 ft. at low water, spring tides; those on the eastern side of the east pier were sunk on the natural surface of the rock. Those on the western side of the west pier, as well as those for the landing pier, were sunk in a depth of 24 ft. at low tide. From the elevation of 6 ft. above low tide the superstructure consists of mass concrete walls, stepped at the back and filled between with excavated material. The railway spur track from the I.C.R. will be extended to the end of the western pier. These piers are intended to be used when necessary, for unloading parts of cargoes from vessels to be docked. The entrance channel has a depth of 30 ft. at low water, spring tides. The landing pier on the west side of the entrance is intended for unloading the dock supply of coal, when delivered by water.

Buildings.—The power-house is 120 ft. by 100 ft., divided by a brick wall into two rooms, 120 ft. by 50 ft.,

one being the boiler room and the other the generator room (Fig. 15); the walls are brick, built on concrete foundation; the roof is built of reinforced concrete slabs, supported by steel I-beams, which were procured from the unused steel of the first Quebec Bridge. The building is provided with extra large windows with steel frames. Skylights and ventilators are also provided. The floor is concrete, overlaid with red tiles; and the lower part of the interior walls for the generator room is finished with a white tile wainscoting, 6 ft. high. Each room is furnished with water closets and wash basins; the water is obtained from the Lauzon village acqueduct.

A special pump in case of fire and the necessary hose are provided. The generator room has an overhead travelling crane of 15 tons capacity. The lifting is done by motor; the travelling gear is worked by hand.

The pump-house is 70 ft. by 47 ft., with foundation walls of concrete, over which brick walls are built (Fig. 16). The floor is at elevation of 16 ft. below low water, spring tides, or 41 ft. below coping. It is finished with red tiles. The interior walls up to coping level are finished with white tiles. The pump-house is also provided with an overhead travelling crane of 10 tons capacity. The chimney is 180 ft. high, built of brick, with an inner shell of fire-brick 100 ft. high. There is an air space of 6 in. between the inner and outer shells; the inside diameter is 11 ft.; the top consists of a cast-iron cap; four lightning-rods, well grounded, are provided to protect the chimney.

It may be stated that the length of the dock was decided on not merely in anticipation of vessels of, say, 900 ft. or over being employed on the St. Lawrence trade, which may not happen for a great number of years, but owing to the great number of applications received every fall from owners of moderate sized vessels for accommodation during the winter, so that repairs may be done at cheaper rates, and the boats be ready for traffic as soon as navigation opens.

The several classes of works in connection with the construction of the dock have been accomplished in a thorough manner both in regard to materials furnished and workmanship; several minor changes which were found to be advantageous were made during construction. The contractors, in all cases, have shown their willingness to give satisfaction in every way irrespective of cost. It must be noted that the works were started shortly before the war and continued without interruption, except in winter, in spite of increased cost of materials and labour. The time required for the construction of the dock is somewhat over four years. It must, however, be remembered that the working season is only six months in each year—concrete works have to be suspended during the first days of November and cannot be resumed until the beginning of May.

The total cost of the works under contract will be approximately 3,365,000 dols. The works have been carried on by the Department of Public Works with Mr. Eugene D. Lafleur as chief engineer—the writer as superintending engineer—Mr. J. K. Laflamme, as resident engineer; Mr. S. Fortin, steel structural engineer has had the approval of plans submitted for the steel structures. The contractors are Messrs. M. P. and J. T. Davis, and Mr. S. Woodward is their superintending engineer.

Industrial Alcohol and Glycerine.—The Ministry of Munitions notify that there are now supplies of alcohol available for industrial purposes, and that manufacturers should be able to obtain their requirements from their usual suppliers without restriction, subject, of course, to the usual regulations of the Board of Customs and Excise. Methylated spirit is again available to the public. Glycerine should, in a few days, be purchasable in the ordinary way from chemists, stores, &c. Arrangements have been made which enable glycerine producers to supply substantial quantities for general use.

The St. Lawrence Navigation.—According to *Canadian Machinery*, an inquiry into the navigability of the St. Lawrence recently carried out by the Quebec Board of Trade justifies the belief that it will be possible by the adoption of certain precautions to keep open the navigation of the St. Lawrence throughout the entire year. The season hitherto has been from the beginning of May till about the end of November. To maintain the navigability of the river during the winter powerful ice-breakers will be needed. Storm shelters will also be necessary and the provision of further buoys and wireless stations.

British Scientific Instrument Research Association.—One of the earliest associations formed under the scheme of the Department of Scientific and Industrial Research, has secured premises at 26, Russell-square, W.C. 1, where offices and research laboratories will be equipped. The first chairman of the association was Mr. A. S. Eaglemont, whose recent lamented death has been a severe loss to the association. The council have elected Mr. H. A. Colefax, K.C., as chairman to fill the vacancy. The vice-chairman is Mr. Conrad Beck, C.B.E., to whose energy and personal influence is largely due the successful formation of the association. Almost all the leading optical and scientific instrument manufacturers are members. The Department of Scientific and Industrial Research is represented by Major C. J. Stewart, Captain F. O. Creagh-Osborne, R.N., C.B., Mr. S. W. Morrison, O.B.E., Colonel R. E. Home, D.S.O., R.A., and Mr. Percy Ashley. The council have recently co-opted as members of their body the Hon. Sir Charles A. Parsons, F.R.S., and Professor J. W. Nicholson, M.A., D.Sc., F.R.S. Sir Herbert Jackson, K.B.E., F.R.S., F.I.C., has been appointed Director of Research, and Mr. J. W. Williamson, B.Sc., secretary of the association,

CATALOGUES.

Heat Treatment.—A further circular issued by Automatic and Electric Furnaces, Limited, 6, Old Queen-street, S.W. 1, deals with the tempering of screw gauges and gives some useful figures compiled from tests made with a view to measure the effect of quenching on the mean effective diameter of the threads.

Hoisting Machinery.—The Brown Hoisting Machinery Company, Cleveland, U.S.A., send a further catalogue of their trolley, tram-rail, hand-travelling, mono-rail, electric and other hoisting and conveying machines. The illustrations, dimension tables and descriptive matter are very clear and fully detailed.

Conveying Machines.—A catalogue issued by Messrs. Hugh Wood and Co., Limited, 65, Fenchurch-street, E.C., gives introductory particulars of a large assortment of machinery made by the Jeffrey Company, for which they are sole agents in this country. The machines include wagon loaders; elevators and stackers; coal crushers; electric locomotives and trucks of storage battery, trolley and crab and reel types; coal cutters; belt conveyors; mine fans, &c. Fully detailed catalogues of any kind of machine are available.

Colliery Electric Transformers.—These are used in coal pits having extensive workings so that the current supply can be brought close to the working face in high tension and there transformed. Messrs. Johnson and Phillips, Limited, Charlton, S.E. 7, send a catalogue leaf of transformers specially designed for this work, mounted on four flanged wheels to run on the pit railway track. They are low built, very compact and made in standard units adapted for connection in parallel. Oil-level gauges and oil draw-off cocks are fitted.

Ball Bearings.—The Rudge-Whitworth Company, Limited, Sparkhill, Birmingham, has erected and equipped a special factory for making ball bearings. The catalogue shows that the new branch of business has been taken up thoroughly. Both English and metric sizes are made to stock. In addition to standard ball journal bearings and ball thrust washers a light ball journal bearing is made which should prove useful for small spindles with light loads—seven sizes are made, the bore of the rings ranging from 1 in. to ¼ in. All the bearings are already widely in use.

Oil Engines.—Messrs. Robey and Co., Limited, Lincoln, issue a catalogue dealing especially with small single and double-cylinder crude oil engines of the two-cycle type. The illustrations and explanatory matter are very clear and instructive. The single-cylinder stationary engines are made in 10 sizes, from 6 brake horse-power to 50 brake horse-power and the double cylinder in eight sizes, from 24 brake horse-power to 100 brake horse-power. Another type neatly and strongly mounted on a four-wheel truck is made in eight sizes, from 4 brake horse-power to 30 brake horse-power.

Water Heating.—A catalogue from Mr. Arthur Roberts, 27, Leyfield-road, West Derby, Liverpool, describes a water-heating boiler built on very sound and substantial lines. A number of straight horizontal tubes are placed over the fire, but in a rectangular water-box. The fire, or hot gas, passes through the tubes from back to front and returns by side flues. The whole, except under the fire, is enclosed in a water shell. The construction gives rapid heating, strong circulation and very little loss by radiation. The tubes are large, with stout walls and made of wrought-iron. The fire-box is of steel. The details are worked out with every care for both safety and convenience.

Engine Dynamometer.—A catalogue from Messrs. Heenan and Froude, Limited, Worcester, very fully describes their water dynamometer for testing the brake horse-power of aircraft and motor car engines. The test sets up and measures an hydraulic pressure, the mechanism being totally enclosed. This method has the advantages of easy starting and the clear indication of variations in the output of power during the run. It is possible to make adjustments in the carburettor, ignition, &c., during the test run and to observe the effects on the dial. The silence of the method as compared with others is also an advantage, as it is very desirable to hear the engine's own noises during a test run free from testing machine noises. The catalogue is interesting reading.

Testing for Magnetism.—The testing of material, such as bars of steel, and of shaped pieces, such as magneto magnets, is described in a catalogue of the Fahy Permeameters, American-made instruments for which Mr. George H. Alexander, Coleshill-street, Birmingham, is the sole agent in this country. One instrument compares the magnetic properties of two steels, one of which is a standard. The magnet meter detects mechanical defects and homogeneities in steel wires, cables, rods, &c. In testing shaped permanent magnets there are two distinct properties to be measured: (1) The flux which determines the initial strength of the magnet and the stability (coercive force) or power to retain the flux in working conditions. The second is only carried out on samples of lots as it involves demagnetising the test-piece.

Coal Meter.—Coal consumption is, generally, measured accurately only in boiler tests. Apart from tests a record is kept of the total consumption in a number of boilers. It would be an undoubted advantage if the coal could be measured and recorded automatically as it enters the furnace of each boiler. This is the object of the Lea coal meter made by the Lea Recorder Company, Limited, 28, Deansgate, Manchester. The catalogue shows the application to a chain grate stoking machine in which the coal enters the furnace through a rectangular opening. The width of this opening does not vary, but the depth is varied by a rising and falling door worked by chain and balance weight. The meter mechanism is influenced by two factors: (1) The height of the opening and (2) the speed of the chain grate. The chain grate driving shaft is fitted with a toothed wheel to drive the recording instrument. All the driving connections to the counting wheel are positive, *i.e.*, by tooth gear or chain and sprocket. Evidently, the counter must be influenced by the speed of the grate and by the height of the movable door to give a correct count. This modification is effected in a simple mechanical way. The instrument contains two toothed drums, the upper of which drives the counting wheel. Between the upper and lower drums is a pinion running free, but secured against longitudinal movement, on a sliding shaft. This shaft is interposed in the chain which connects the falling door with its balance weight, so that the pinion is moved to and fro along the drums as the door is raised or lowered. The drums are long enough to allow directly for this movement. The teeth on the upper drum are continuous, both on its length and round its periphery. On the lower drum the teeth are removed from a spiral space. The effect is that while the pinion is always in mesh with the upper drum it gets a varying drive from the lower. With the coal door fully open the pinion (and, therefore, the upper drum and counting wheel) are continuously rotated; as the door is lowered the pinion is moved along the lower drum and finds a decreasing number of teeth to drive it, though the drum is continuously rotating; when the door is shut, excluding further supplies of coal, the pinion reaches a part where there are no teeth. This gear is unusual, but the merit lies in its application. It gives a direct mechanical drive in a form which is not affected by the trying conditions of the boiler-house. All the mechanism may be fairly slack in fit when cold and it will register just as accurately as when the heat causes an expansion of the parts. The principle of measuring a flow of coal in practically the same way as a flow of water may appear rather bold, but it has been found by experiment to be so reliable that the instrument is stated to be correct within 5 per cent. Actual weighing is not more exact unless fine corrections are made according to the varying moisture content of the coal. One standard instrument serves for all boilers. The recording is in plain figures and is cumulative. The value of the unit is found by experiment. For example (the figures are fanciful), assume that a weighed or measured ton of coal is passed through in 97 revolutions of the counting wheel—then the total count for a day, week, &c., is divided by 97 to find the number of tons consumed by each boiler. The meter should prove extremely useful, in co-operation with other recording instruments, especially in checking the performance of individual boilers.

Removal of Certain Restrictions on the Manufacture of Iron and Steel.—The Minister of Munitions announces that until further notice iron and steel makers are at liberty to accept and execute orders for iron and steel ranking for priority below Class B, subject only to conditions shortly to be issued as regards prices, and to the Order as to priority dated March 8, 1917. For this purpose, the operation of such clauses of the Control of Steel Supplies Order of November 20, 1916 (as amended by Order of December 14, 1917) prohibiting the manufacture of iron and steel for orders ranking below Class B, is suspended.

Molybdenite Prospecting in Queensland.—Considerable interest is being displayed (says a Queensland advice) in the belt of molybdenite country situated north of the junction of the mill stream with the wild River, Herberton district. Surface prospecting has been carried on for some time with very promising results, and a shaft being put down proves the deposits to improve in value at a depth. A syndicate of Cairns and southern mining speculators are interesting themselves in the property. Several leases have recently been taken up, and are likely to be worked in a vigorous way in the early future.

Reinforced Concrete Floor Slabs.—We have received from Mr. C. W. Hobson, of 3, St. James'-square, Manchester, a set of tables showing the British Reinforced Concrete Company's fabric required for reinforcing floor slabs of different spans and thicknesses and for various loadings. This fabric is made at Trafford Park, Manchester, from mild steel wire having an elastic limit of 75,000 lb. per square inch, and an ultimate strength of from 80,000 lb. to 110,000 lb. per square inch. The unit stresses adopted in preparing the tables are 25,000 lb. per square inch for the steelwork and 6,000 lb. for the concrete. The tables are strongly mounted on linen and will undoubtedly prove of great assistance to architects in saving them from the labour of many tedious and tiresome calculations.

The Institute of Metals.—A general discussion on "The Relation of Science to the Non-Ferrous Metals Industry" will form the central feature of the next annual general meeting of the Institute of Metals. At that meeting there will also be presented several important papers, the publication of which has been withheld owing to the operation of the Censorship. A Local Section of the Institute of Metals has been formed in Sheffield, the recently dissolved Sheffield Society of Applied Metallurgy forming the nucleus of the new section. A ballot for the election of members of the Institute of Metals will be taken on Wednesday, December 18. The necessary membership application form, which is combined with an illustrated booklet, can be had from the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria-street, S.W. 1.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in Italics.

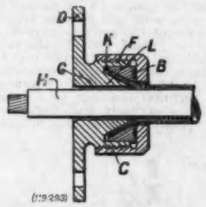
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

ELECTRICAL APPARATUS.

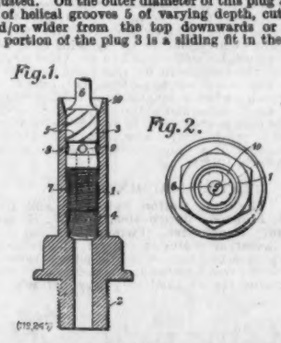
119,293. L. Newitt, Chatham, and Callender's Cable and Construction Company, Limited, London. Electric Cables. (3 *Figs.*) September 28, 1917.—This invention relates to glands for electric cables for use where such cables enter or leave terminal boxes, and is applicable for use with cables sheathed with lead or other material forming in itself a water-tight sheath. The gland comprises a body, an adaptor B, and a screw-up device C. The gland body is preferably cast with a flange D and cylindrical boss F. The gland is attached to the junction-box by means of flange D. The cylindrical boss F is provided on the outside with a screw thread to receive the recessed nut C and in the centre a hole G is provided through which the insulated cable H passes. The end of the boss F remote from the flange D has formed within it an annular recess K to



receive the adaptor B, leaving a conical-shaped projection L. In using a gland according to this invention the flange D is bolted to a corresponding facing on the joint-box and the recessed nut C and adaptor B threaded over the sheath of the lead-covered electric cable to be jointed. The lead sheath of the cable is then cut back to the proper distance and the end of the lead sheath is opened out and provided with a coned end similar in dimension of the cone L. The end of the electric cable is then introduced through the gland hole G and moved forward into the joint-box until the lead sheath engages with the cone L. The adaptor B is then brought forward over the sheathing and into the recess K and finally the recessed nut C is tightened up in position, compressing the lead sheath between the adaptor B and the conical projection L. (*Accepted October* 9, 1918.)

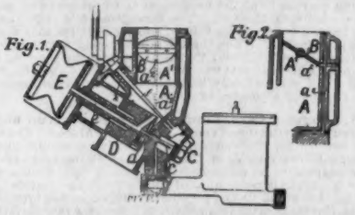
GAS ENGINES, PRODUCERS, HOLDERS, &c.

119,247. W. Javes, Derby. Carburettors. (5 *Figs.*) March 21, 1917.—This invention relates to carburettors of the type wherein the jet tube spraying device is fitted with an adjustable plug having helical grooves of varying size, to emit the fuel in a whirling spray so as to mix more intimately with the air. According to one form of the invention, the jet tube 1 having a screw thread 2 formed at its lower end to screw in the base of the carburettor in the ordinary manner, is fitted with a cylindrical plug 3 which is, preferably, screw threaded at its lower end to screw in the said jet tube 1 so that its height can be readily adjusted. On the outer diameter of this plug 3 is formed a number of helical grooves 5 of varying depth, cut gradually deeper and/or wider from the top downwards or *vice versa*. The upper portion of the plug 3 is a sliding fit in the jet tube 1



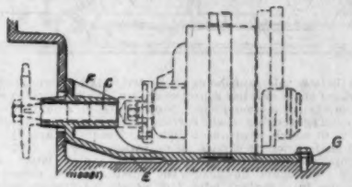
and can be adjusted by means of an upwardly extending rod 6, the rod 6 being controlled from the exterior of the carburettor The plug 3 is provided at its lower end with a central aperature 7 and a circumferential groove 8 with connecting holes 9 to the central aperture 7, so that liquid fuel will pass up through the base of the jet tube 1 from the float chamber, then up the central aperture 7 to the groove 8 when the suction of the engine will draw it through the helical grooves 5 causing it to issue at the top of the jet 1 in the form of a fine whirling spray. The spray is spread out in the form of a cone by countersinking or internally tapering the top of the jet tube as shown at 10. It will thus be seen that the area of the jet orifices 5 can be varied by the height of the plug 3 in the jet tube 1, the area being determined by the depth and/or width of the helical grooves 5 at the line where the countersunk portion 10 of the jet tube 1 meets the internal wall thereof. (*Accepted October* 9, 1918.)

119,187. Wolseley Motors, Limited, E. Reeve and A. A. Remington, Adderley Park, Birmingham. Carburettors. (2 *Figs.*) March 15, 1918.—This invention relates to the type of carburettor in which the depression is maintained substantially constant by utilising the engine suction for lifting a weight valve which controls the main air supply and simultaneously controls the main fuel supply. A is the carburettor chamber and A1 the throttle chamber, B a throttle of the butterfly type, C the main jet nozzle, D the weight valve, *c* the needle valve which is carried by the weight valve and controls the effective area of the outlet from the nozzle C, and E a bellows device which is constantly in communication with the chamber A through the hollow stem *e* of the weight valve, whereby the weight valve is controlled by the rarity of the atmosphere within the chamber A. An air channel *a* is formed up in the slanting surface of the carburettor



chamber through which the main jet discharges into such chamber, and this channel communicates with a passage *a*1 which is formed in the body of the carburettor and communicates with a port *a*2 which opens into the throttle chamber A1 in such position that, when the throttle B is closed, its lower edge closes the port *a*2. When the engine starts with the throttle only slightly open, a rush of air is drawn by the suction in the mixture pipe beyond the throttle along the channel *a* and through the passage *a*1 and port *a*2, and the rush of air across the mouth of the jet nozzle C breaks up the surface tension of the jet and causes initial flow of the fuel, and during slow running of the engine will maintain the flow of fuel. (*Accepted October* 2, 1918.)

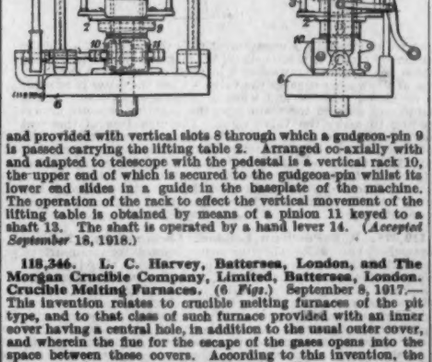
118,801. R. W. Maudsley, Coventry, and The Standard Motor Company, Limited, Coventry. Internal-Combustion Engines. (3 *Figs.*) March 7, 1918.—This invention relates to an improved method of mounting a magneto in relation to the combustion engine for which it furnishes electric ignition.



According to this invention, a magneto baseplate E for connecting to the internal-combustion engine, is provided with a bearing F at one end to carry the driving shaft C to which the magneto A is coupled, whereby the magneto and its driving shaft can be moved as a unit, without interfering with the coupling. (*Accepted September* 18, 1918.)

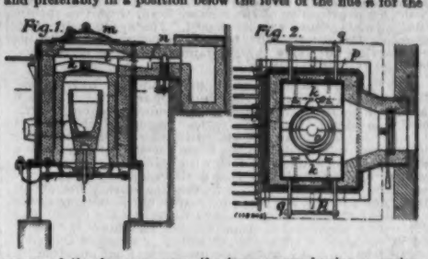
MINING, METALLURGY, AND METAL WORKING.

118,704. A. P. Smith, Coventry. Foundry Moulding Machines. (2 *Figs.*) September 27, 1917.—This invention has reference to foundry moulding machines and has for its object to provide a machine which gives an equally true lift for all heights within the capacity of the machine. 2 represents the lifting table carrying the adjustable stools 3, and provided with a central collar 4 adapted to slide truly upon a single central pedestal 5. The pedestal, which is rigidly mounted on the base-plate 6, and carries the work table 7 at its upper end, is hollow



and provided with vertical slots 8 through which a gudgeon-pin 9 is passed carrying the lifting table 2. Arranged co-axially with and adapted to telescope with the pedestal is a vertical rack 10, the upper end of which is secured to the gudgeon-pin whilst its lower end slides in a guide in the baseplate of the machine. The operation of the rack to effect the vertical movement of the lifting table is obtained by means of a pinion 11 keyed to a shaft 13. The shaft is operated by a hand lever 14. (*Accepted September* 18, 1918.)

118,346. L. C. Harvey, Battersea, London, and The Morgan Crucible Company, Limited, Battersea, London. Crucible Melting Furnaces. (6 *Figs.*) September 8, 1917.—This invention relates to crucible melting furnaces of the pit type, and to that class of such furnace provided with an inner cover having a central hole, in addition to the usual outer cover, and wherein the flue for the escape of the gases opens into the space between these covers. According to this invention, the inner cover is made in sections adapted to slide upon the top of the inner lining to allow of their ready removal from above the furnace chamber. *k* indicates the inner cover which is provided according to this invention, this cover being made in two parts adapted to lie in a chamber *l* formed beneath the ordinary cover *m* and preferably in a position below the level of the flue *n* for the



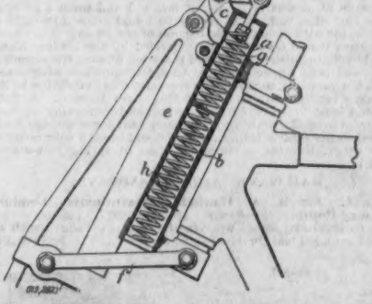
escape of the furnace gases, the inner cover having a central opening *o* for the passage of the gases. *p*, *p* indicate lateral recesses into which the parts of the cover *k* may be withdrawn, rods *q*, *q* being fixed to the parts to allow of their being moved. (*Sealed*).

118,750. J. Gaunt, East Finchley, D. Brookfield, Holloway, and J. Tylor and Sons, Limited, London. Smelting Furnaces. (2 *Figs.*) November 24, 1917.—This invention relates to furnaces used for smelting and refining metals. The improvements relate to the preheater or metal container that commonly constitutes the top of the furnaces and acts as the cover and uptake for the spent gases. To the top of the furnace *a* is applied a circular ring *b* provided on its upper surface with a groove into which the bottom edge of the preheater rests. This preheater consists of an outer shell *g* lined with refractory material to form the interior hopper *i* to receive the metal to be dealt with. This hopper *i* is combined with blocks *j* of refractory

material situated in the lower portion of the shell *g* and so shaped as to form a depending lip to the bottom of the hopper *i*, wherein are provided slotted passages *m* that form extra channels through which the products of combustion and blast are allowed to pass freely. This depending lip and slotted passages *m* constitute deflecting surfaces whereby the products of combustion from the interior of the furnace are led through and commingle with the contents of the hopper *i* of the preheater on their way to the uptake *k*. The top of the preheater *g* is provided with a hinged cover *n*. The preheater is mounted in such a manner that it can be readily raised from its joint in the ring *b* and swung out of the way to permit of the crucible being removed from the furnace. (*Accepted September* 18, 1918.)

MOTOR ROAD VEHICLES.

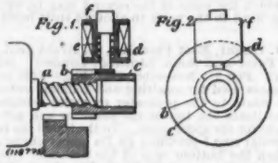
119,282. The New Hudson Cycle Company, Limited, Birmingham, and T. A. Tisdell, Birmingham. Motor Cycle Spring Forks. (3 *Figs.*) September 27, 1917.—This invention relates to spring forks for motor cycles mounted with link mechanism in such a manner that the wheel is enabled to have a substantially up-and-down movement and also a substantially forward and rearward movement. The invention comprises a spring fork of this type which is characterised in that the resilient medium co-operates with a part which is rigid with the steering head. A tubular member *a* is adapted to slide substantially vertically. This tubular member may be located telescopically within the steering head to slide vertically therein and project from the top thereof. Alternatively, as shown, it may be mounted to slide within a tubular member *b* mounted in front of the steering head. At its upper extremity the tubular



member carries a forwardly projected bearing *c* for a bell crank lever *d*. One arm of this bell crank lever is pivotally connected to the top of the fork *e*. The other arm of the bell-crank lever extends rearwardly to a position above the telescopic sliding member. The fork proper is connected to the lower extremity of the steering head by links *f*. A spring *g* is coupled at its upper extremity to the bell-crank lever *d* and extends downwardly into the interior of the telescopic sliding member. Said spring is coupled at its lower extremity to said telescopic sliding member or to the part appertaining to the steering head in which said sliding member operates. In its substantially upward movement, therefore, the fork proper carries upwardly the tubular member functioning as the bearing for the bell-crank lever. In the substantially forward and rearward movements of the wheel, the top of the fork moves rearwardly and forwardly by virtue of the bell-crank lever, the rearwardly extending arm of which in these movements moves upwardly and downwardly. The coiled

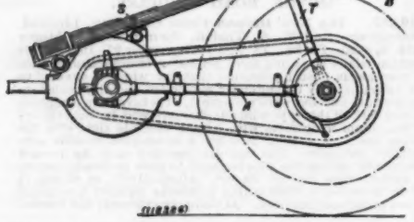
spring may, at its lower extremity, be coupled to the telescopic sliding member at a position mid-way in the length of the latter, and another spring *h* may couple said telescopic sliding member to the lower extremity of the steering head, these two springs being advantageously axially aligned. The upper spring thus intercepts the substantially horizontal movements, while the lower spring intercepts the substantially vertical movements. (*Accepted October* 9, 1918.)

118,775. H. Lucas, Birmingham, and C. L. Breeden, Birmingham. Electric Starting Apparatus. (3 *Figs.*), January 10, 1918.—This invention provides improved electric starting apparatus for motor vehicle engines of the screwed pinion type. The invention comprises the combination with a pinion screw connected with the armature shaft of the starting mechanism, and adapted to mesh with gear teeth on the engine flywheel, of a solenoid controlled device adapted to impose on the pinion frictional resistance to rotation during the pinion meshing operation. The armature shaft *a* of the starting motor is extended at one end and screwed to receive the pinion *b* as heretofore. An extension *c* is provided on one side of the pinion and in conjunction with such extension is arranged any convenient friction device which is normally held out of action by a spring and brought into action by a solenoid. Preferably



such solenoid also acts as a resistance in series with the motor. When the starting switch is closed, the excitation of the solenoid causes the friction device to grip the pinion and retard or prevent its rotation without interfering with its axial movement on the screw into mesh with the gear wheel to be driven. When the pinion is properly engaged, it may strike a switch and by cutting out the solenoid permit a full flow of current to the motor. The latter then exerts its maximum turning effort. Alternatively, the cutting out of the solenoid and admission of a full current to the armature may be controlled by a hand switch. In any case, the solenoid is prevented from coming into action during the return of pinion. In the device shown, the pinion extension *c* is gripped externally by a plunger *d*, the operative end of which is shaped to bear on or partially embrace the extension. This plunger is ordinarily held out of action by a spring *e*. A solenoid *f* as above described brings it into action. (*Accepted September* 18, 1918.)

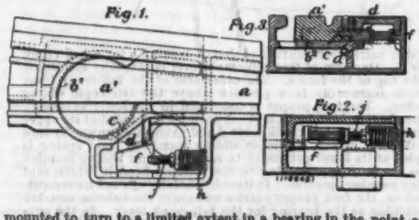
118,326. Coventry Premier, Limited, Coventry, and G. Funck, Coventry. Motor Road Vehicles. (2 *Figs.*) August 23, 1917.—This invention relates to chain-driven-motor-road vehicles of the type wherein a trailing frame is employed, pivoted at its forward end to the main frame or a part carried thereby and having a driving road wheel mounted at its trailing end, which wheel carries the sprocket for the chain drive. According to this invention, in a motor vehicle of the type described, there are combined with the trailing frame A and the driving wheel B mounted therein, eccentric sheaves C which constitute the pivot about which the forward ends of the frame A swing, the said eccentric sheaves being adjustable in the trailing frame and serving to effect adjustment of the chain tension as well as to pivot



the trailing frame on hollow trunnions carried by the gear-box. The invention further comprises the employment of a chain-case I fitted upon an eccentric sheave at one end and upon a circular boss at the other end, so as always to remain closed in spite of provision for adjustment of the tension of the chain. The chain-case is constituted by a side plate carried by the trailing frame and a detachable dished cover and is a snug fit over the eccentric sheave and boss respectively, so that the sprocket wheels and chain are completely enclosed, the eccentric sheave rotating in the side plate for the adjustment of the chain tension. A yoke member T is provided bridging the wheel and connecting together the rear ends of the trailing frame, and cantilever springs S are attached to the vehicle frame at one end and to such yoke member at the other, forming a simple method of spring suspension. (*Sealed.*)

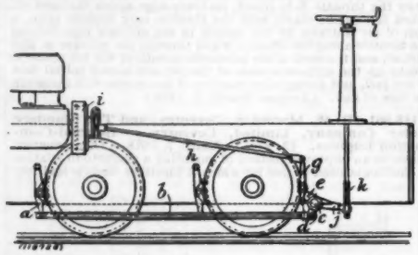
RAILWAYS AND TRAMWAYS.

118,648. Sir R A. Hadfield, Westminster, London. Tramway Points. (6 *Figs.*) April 13, 1917. This invention relates to tramway points wherein the tongue is formed with an enlarged rounded end (hereinafter referred to as the heel) that is



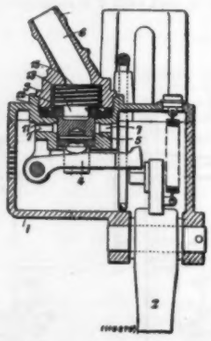
mounted to turn to a limited extent in a bearing in the point or switch body and is held vertically and endways in place by a holding device that extends through a lateral opening in the point body and bears either directly or indirectly against the heel of the tongue at a part thereof above its bottom surface and the adjacent surface of the bearing therefor, in such manner as to hold the heel vertically and longitudinally against its bearing. According to the construction shown, the heel a^1 of the tongue *a* is formed at one side and in advance of its centre, with a grooved and an undercut bevelled portion *c* inclined inwardly and upwardly and is held in place by a sliding block *d* that has a corresponding bevelled edge portion d^1 adapted to engage the bevelled portion *c* at a part above the bearing surface b^2 upon which the heel works and hold it firmly down on such bearing surface so as to prevent it rising and also to force it backwardly into close contact with the surrounding portion b^1 of the bearing so as to prevent any gap or looseness between the two. The arrangement is such that when the block *d* is moved back free from the heel, the tongue *a*. can be readily lifted out. The block is pressed against the heel a^1 by an adjustable wedge block *f* that is acted upon by a spring *h* acting through a bolt *j* so that wear between the heel a^1, bearing b^1 and block *d* will automatically be taken up in an advantageous manner. (*Accepted September* 18, 1918.)

118,728. Baguley Cars, Limited, Burton-on-Trent, and L. Bentall, Burton-on-Trent. Railway Motor Cars. (1 *Fig.*) October 25, 1917.—This invention relates to brake and clutch mechanism of vehicles of the type in which the brake and clutch are adapted to be collectively operated in such a manner that while the brake is being applied the clutch is automatically disengaged. According to the present invention, in this type of mechanism, the brake actuating provision involves a cam surface which is adapted to co-operate with the clutch mechanism to effect the desired automatic release of the clutch when applying the brake. The pivoted brake shoes *a* are coupled to a rod *b*. A rocking shaft *c* has at or near each extremity an arm *d* rigidly



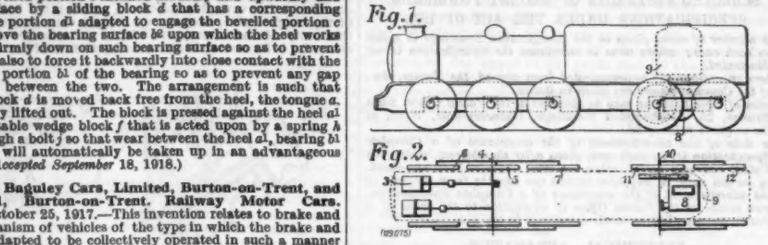
secured thereto, said arms being connected to the coupling rods *b*. The rocking shaft also has a projection *e* which co-operates with a roller carried by a lever *g* which is connected by a link *h* to the clutch *i*. The rocking shaft carries a third arm *j*, the outer extremity of which co-operates with a nut movable axially of a vertical shaft *k* which carries an operating lever *l*. Actuation of such operating element traverses the nut, and the latter rocks the shaft *c* which first disengages the clutch and then moves the brake shoes into contact with the wheels. Actuation of the operating element in the reverse direction first releases the brake shoes and afterwards allows the clutch to re-engage. (*Accepted September* 18, 1918.)

118,679. J. W. Cloud, London, and J. W. Cross, London. Fluid Pressure and Vacuum Brakes. (2 *Figs.*) September 6, 1917.—This invention relates to train pipe vent valves for use with fluid pressure and vacuum brakes. The train pipe vent valve device is arranged in a casing 1 and comprises the lever 2 pivoted to permit of its displacement when brought into engagement with a projection located on the track. The lever 2 in its normal position supports the arm 4, which holds a vent valve 5 closed. The valve 5 controls the flow of fluid under pressure from a passage 6 leading to the train pipe and the atmosphere. The valve 5, when closed, engages a flexible valve seat 9 constituted by a circular washer, the outer portion of which is gripped firmly between a flange 11 and an annular



member 12 forced into engagement with the outer portion of the washer by means of a screw-threaded member 13. 15 is a spring which bears upon the washer 9 in such manner that the lower face of the washer engages the valve 5 when the latter is brought to its closed position and when a difference of pressure exists inside and outside the train pipe the superior pressure always tending to make the valve tight. The operation of the vent valve device as a whole does not differ materially from known constructions, it being understood that when the lever 2 is moved by the co-operating lever located on the track, the arm 4 falls and allows the valve 5 to move to its open position, thereby venting fluid from the train pipe through the passage 6 and ports 7 to the interior of the casing 1 from whence it escapes to the atmospere. (*Accepted September* 18, 1918).

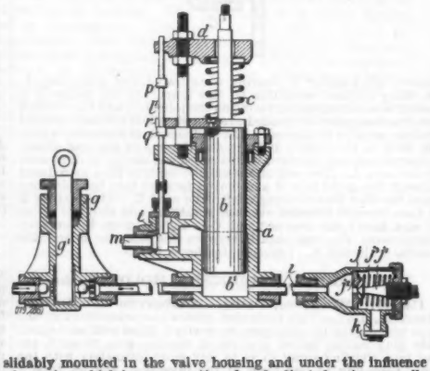
119,075. R. S. Portham, London. Locomotives. (2 *Figs.*) September 18, 1917.—This invention relates to steam-driven locomotives and particularly to power plants therefor. The improved locomotive power plant, according to the invention, comprises a reciprocating engine, or plurality thereof, which exhausts into a turbine or turbines, which, in turn is, or are, connected to a suitable condenser, preferably of the evaporative type. The reciprocating engine or engines may be connected to one or more driving axles of the locomotive, while the turbine or turbines may be connected to other driving axles, such axles, if desired, being coupled together in the usual manner. The turbine or turbines is, or are, connected to the axle or axles by means of suitable reduction gearing, which may be of the mechanical, hydraulic or electrical type. 3 designates the reciprocating engine connected to the axle 4 of the driving wheels 5 which are coupled to the wheels 6, 7. Exhaust steam from the engine passes to the turbine 8, through suitable con-



nections (not shown), and from thence to the condenser 9, which is preferably of the evaporative type. The turbine is geared to the axle 10 of the wheels 11 by means of the reduction gearing; the wheels 11 being coupled to the wheel 12. (*Accepted October* 2, 1918.)

STEAM ENGINES, BOILERS, EVAPORATORS &c.

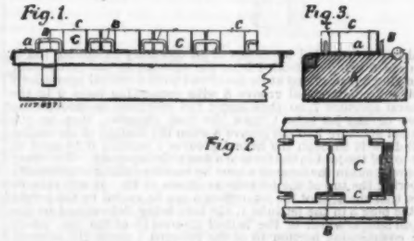
119,286. H. Ellis, Jarrow-on-Tyne. Governors. (2 *Figs.*) September 27, 1917.—The invention relates to governors for steam engines, and the object is to provide an improved device characterised by the fact that it relies for its function on hydraulic pressure. *a* designates an hydraulic ram, the plunger *b* of which is adapted for connection to the valve controlling the main steam supply to the engine, said plunger working in a chamber b^1 and being under the influence of a spring *c* which serves to hold the plunger in its normal lower position and to return the plunger to this position after its throttling operation. The tension of the spring *c* may be regulated by means of an adjustable crosshead *d*. To the ram chamber b^1 is connected the discharge pipe of the pump *g*, the plunger g^1 of which is adapted to be connected to and operated by a suitable part of the engine to be governed. *i* designates a discharge pipe leading from the ram chamber to a non-return valve chamber *j* comprising a normally stationary valve proper j^1 co-operating with a movable valve seat j^2, the latter being



slidably mounted in the valve housing and under the influence of a spring which is so proportioned and adjusted as to normally hold the valve seat clear of the valve so that the water discharged by the pump *g* can normally pass freely beneath the plunger *b* without actuating the latter, and thence escape to the pipe *k*. The valve j^1 is adjustable to enable it to be set to close at predetermined pressures, the valve-stem being provided with a screw thread engaging in a correspondingly tapped bore in the end of the valve casing, thus enabling the valve to be moved with respect to its seat j^2 and the spring being compressible by means of the adjustable end screwed on the valve housing. In order to enable the pressure in the ram chamber to be relieved after the ram has been raised to perform its throttling function, a valve *l* is provided which is adapted to establish communication between the ram chamber and a drain pipe *m*. The valve may be of the sluice type as shown, and is provided with an upwardly extending rod l^1 provided with abutments *p*, *q* adapted to be alternately engaged by a tappet *r* connected to the plunger *b*. (*Accepted October* 9, 1918.)

TEXTILE MACHINERY.

117,657. The Fine Cotton Spinners' and Doublers' Association, Limited, Manchester, and W. H. Beverley, Miles Platting, Manchester. Twiners. (8 *Figs.*) July 23, 1917.—This invention relates to twiners, and is designed to provide for a plummet rail upon which the plummets rest without obstruction to the free removal and replacement of the listing or other covering thereon, and to prevent irregular drag or



tension. According to this invention, fixed transverse retaining wires in the plummet rails are dispensed with so that the listing or other covering *a* can be applied to or placed upon the whole length of the rail A without any obstruction, and longitudinally of the rail a number of staples B are substituted for the M-shaped wires, and the plummets C are formed each with a lug or projection *c* to fit between the staples. (*Sealed.*)